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(71)Applicant : NAMCO LTD
(72)Inventor : MURATA HIROYUKI
YOKOTA TAKASHI

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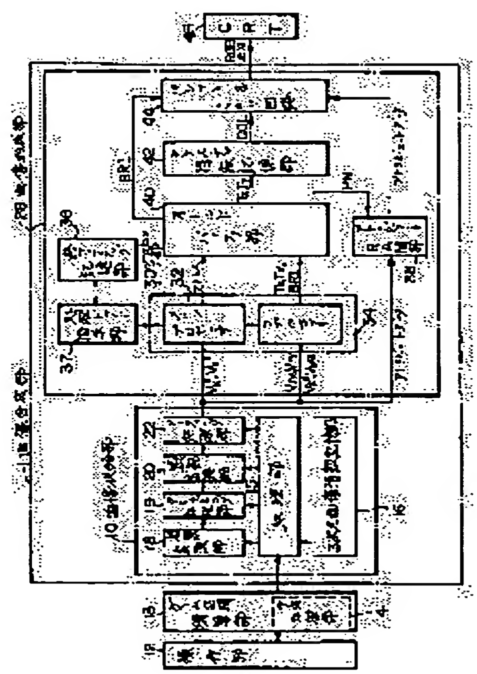
(54) IMAGE COMPOSING DEVICE

(57)Abstract:
PURPOSE: To provide the image composing device which can compose an image of high quality in real time.
CONSTITUTION: This image composing device performs arithmetic processing for image composition in order from a polygon on this side of a display screen. An end flag storage part 36 is stored with an end flat at an address location corresponding to a dot where the arithmetic processing is completed. Then a process dot indication part 37 reads the end flag out and indicates a dot to be processed to a processor part 30. In this case, the process dot indication part 37 writes the end flag of the decided dot to be processed back to the end flag storage part 36 and sends an indication to the processor part 30 so that arithmetic processing is performed only for the dot to be processed. Consequently, the image composition can be performed in order from the polygon in front of the display screen and arithmetic processing for a hidden surface part whose processing is already ended can be omitted.



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CLAIMS

[Claim(s)]

[Claim 1] It is the image synthesizer unit which carries out transparent transformation of the three-dimension image which consists of three-dimension polygons on predetermined plane of projection, and compounds a false three-dimension image. An image formation means to ask for the image information of each dot which constitutes a polygon sequentially from the polygon located to the front to the display screen based on each top-most-vertices image information of said polygon by which transparent transformation was carried out by predetermined data processing, A termination flag storage means by which the termination flag which shows termination of data processing to the address position corresponding to the dot which data processing by said image formation means ended is memorized, Read said termination flag from said termination flag storage means, and a processing dot directions means to direct the dot which should process based on this termination flag for said image formation means is included. While returning the termination flag of the dot which determined to process said processing dot directions means to said termination flag storage means as a dot which processing newly ended The image synthesizer unit characterized by attaining improvement in the speed of processing by directing that only the dot which determined to process to said image formation means performs said data processing.

[Claim 2] The image synthesizer unit characterized by to direct the dot which said termination flag storage means should memorize every two or more dots, said processing dot directions means should read this termination flag every two or more dots, and said termination flag should determine the dot which should process based on the termination flag in every two or more read dots, and should process for said image-formation means in claim 1.

[Claim 3] In claim 1 or 2, said data processing in said image formation means Based on each top-most-vertices image information of the polygon by which transparent transformation was carried out, the right-and-left profile point which is a point that the border line and each scanning line of a polygon cross is searched for. It is carried out by asking for the image information of each dot on the scanning line which connects this right-and-left profile point. Said processing dot directions means By using the mask pattern which directs that it is the dot surrounded by said right-and-left profile point, and said termination flag which directs that it is the dot which processing already ended The image synthesizer unit characterized by determining the dot which processing has not ended among the dots surrounded by the right-and-left profile point.

[Claim 4] The image synthesizer unit characterized by asking for the image information of each dot from which said image formation means constitutes said polygon based on the color information on said each polygon, and the display coordinate information on each top-most vertices by predetermined data processing in claim 1 thru/or either of 3.

[Claim 5] The image synthesizer unit characterized by asking for the image information of each dot from which said image formation means constitutes said polygon based on the display coordinate information and texture information of each top-most vertices on said polygon by predetermined data processing in claim 1 thru/or either of 3.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to an image synthesizer unit and the image synthesizer unit which can carry out quality image composition to real time.
[0002]
[Description of the Prior Art] Various things are known as an image synthesizer unit used for the operation simulator of the conventional, for example, three dimension, game or an airplane, and various vehicles etc. In such an image synthesizer unit, the image information about the three-dimension body 300 shown in drawing 10 is beforehand memorized by equipment. And image display of the false three-dimension image 308 is carried out on the screen 306 by carrying out transparent transformation of this image information on a screen 306. If a player 302 operates rotation, advancing side by side, etc. with a control panel 304, equipment will carry out data processing, such as rotation, advancing side by side, etc. to the three-dimension body 300, to real time based on this actuation signal. Then, transparent transformation of the three-dimension image with which data processing, such as this rotation, was performed is carried out on a screen 306, and a false three-dimension image is displayed. Consequently, a player 302 becomes possible [that rotation advancing side by side, etc. make the three-dimension body 300 real time by own actuation], and can carry out the virtual experience of the imagination three-dimension space.
[0003] An example of the configuration of such an image synthesizer unit is shown in drawing 11 . In addition, in the following explanation, explanation is advanced taking the case of the case where an image synthesizer unit is applied to a three-dimension game.
[0004] As shown in drawing 11 , this image synthesizer unit is constituted by a control unit 510, the game space operation part 500, the image composition section 512, and CRT518.
[0005] In the game space operation part 500, a setup of game space is performed according to the game program memorized by the actuation signal from a control unit 510, and the central-process section 506. That is, the operation of in which direction to arrange the three-dimension body 300 in which location is performed.
[0006] The image composition section 512 is constituted including the image feed zone 514 and the image formation section 516. And in the image composition section 512, image composition of a false three-dimension image is performed according to the setting information on the game space by the game space operation part 500.
[0007] Now, in this image synthesizer unit, the three-dimension body which constitutes game space is expressed as a polyhedron divided into the polygon of a three dimension. For example, it sets to drawing 12 and the three-dimension body 300 is the polygon (1) of a three dimension. - (6) (polygon (4) - (6) does not illustrate) It is expressed as a divided polyhedron. And a coordinate, accompanying data, etc. of each top-most vertices of this three dimension are memorized by the three-dimension image information storage section 552 (it is hereafter called top-most-vertices image information). [of a polygon]
[0008] In the image feed zone 514, various kinds of coordinate transformation, such as various kinds of operations, such as rotation, advancing side by side, etc. to this top-most-vertices

image information, and transparent transformation, is performed according to the setting information on the game space operation part 500. And after the top-most-vertices image information which data processing ended is rearranged in predetermined sequence, it is outputted to the image formation section 516.
[0009] The image formation section 516 is constituted including the polygon generating circuit 570 and the pallet circuit 580, and the polygon generating circuit 570 is constituted including the profile point operation part 324 and the Rhine processor 326. In the image formation section 516, data processing which smears away all the dots inside a polygon by predetermined color data etc. is performed by the following procedures.
[0010] First, in the profile point operation part 324, the right-and-left profile point which is an intersection of the border lines AB, BC, CD, and DA of a polygon etc. and the scanning line calculates. Next, it is smeared away by the color data with which between LQ in the part surrounded by these right-and-left profile points, for example, drawing 12 , and between QR were specified by the Rhine processor 326. In drawing 12 , it is smeared away by blue color data between red and QR between LQ. Then, RGB conversion is carried out in the pallet circuit 580, and an output indication of this painted-out color data is given from CRT518.
[0011]
[Problem(s) to be Solved by the Invention] By the way, when such a continuous tone activity is done and a polygon and a polygon lap, it is necessary to display on a screen only the part which sees from a view among polygons and is in a near side. For this reason, in the conventional image synthesizer unit, the technique smeared away one by one from the polygon which is in a back side to the display screen was taken.
[0012] however, with this kind of image synthesizer unit, it is required that an image processing should be carried out to real time, and it usually needs to update the image data for one screen (a case — depending — **** — two screens) every [every field 1 /] 60 seconds. Therefore, if the rapidity of an image processing is required of the image synthesizer unit concerned and this rapidity is not collateralized, image quality is made to fall to it as a result. And the processing part which carries out rate-limiting [of the rapidity of this image processing] most is a processing part which finally smears away each dot in a predetermined color, and goes.
[0013] However, in the conventional image synthesizer unit, the technique of having smeared away one by one and going from the polygon in the back side of the display screen, was taken. Therefore, finally the surface integral of all the polygons that appear in 1 field, and this continuous tone processing that starts most as for time amount had to be performed. However, the part in which the polygon and the polygon put each other and hid is a part which finally is not displayed on a screen, and it means that the conventional example had performed useless processing in this part. For this reason, the conventional image synthesizer unit had achievement of the technical technical problem that it processes at a high speed inadequate for real time.
[0014] Furthermore, when continuous tone of a color had to be performed from the polygon which is in the inner part of the display screen in this way, the number of polygons which should be displayed on a screen increases and the continuous tone processing of a color to a polygon is not completed during 1 field period, it will lose from the data of a front polygon. However, it is the polygon which usually looks good to a player as the polygon before a screen, and is the constitutionally most important polygon of a game. Therefore, it was not desirable that the data of such an important polygon lost, also when collateralizing the high quality nature of a screen.
[0015] This invention is made in view of the above conventional technical problems, and especially the place made into the purpose is to offer the optimal image synthesizer unit for carrying out an image processing to real time.
[0016]
[Means for Solving the Problem] The image synthesizer unit applied to this invention in order to attain said purpose It is the image synthesizer unit which carries out transparent transformation of the three-dimension image which consists of three-dimension polygons on predetermined plane of projection, and compounds a false three-dimension image. An image formation means to ask for the image information of each dot which constitutes a polygon sequentially from the polygon located to the front to the display screen based on each top-most-vertices image

information of said polygon by which transparent transformation was carried out by predetermined data processing, A termination flag storage means by which the termination flag which shows termination of data processing to the address position corresponding to the dot which data processing by said image formation means ended is memorized, Read said termination flag from said termination flag storage means, and a processing dot directions means to direct the dot which should process based on this termination flag for said image formation means is included. While returning the termination flag of the dot which determined to process said processing dot directions means to said termination flag storage means as a dot which processing newly ended It is characterized by attaining improvement in the speed of processing by directing that only the dot which determined to process to said image formation means performs said data processing.
[0017] In this case, said termination flag is memorized by said termination flag storage means every two or more dots, said processing dot directions means reads this termination flag every two or more dots, and it is desirable to direct the dot which should determine the dot which should process based on the termination flag in every two or more read dots, and should be processed for said image formation means.
[0018] Moreover, said data processing in said image formation means is due to each top-most-vertices image information of the polygon by which transparent transformation was carried out in this case. The right-and-left profile point which is a point that the border line and each scanning line of a polygon cross is searched for. It is carried out by asking for the image information of each dot on the scanning line which connects this right-and-left profile point. Said processing dot directions means It is desirable to determine the dot which processing has not ended among the dots surrounded by the right-and-left profile point by using the mask pattern which directs that it is the dot surrounded by said right-and-left profile point, and said termination flag which directs that it is the dot which processing already ended.
[0019] Moreover, said image formation means can be constituted so that it may ask for the image information of each dot which constitutes said polygon by predetermined data processing based on the color information on said each polygon, and the display coordinate information on each top-most vertices.
[0020] Furthermore, said image formation means can also be considered as the configuration which asks for the image information of each dot which constitutes said polygon by predetermined data processing based on the display coordinate information and texture information of each top-most vertices on said polygon.
[0021]
[Function] According to this invention, data processing which asks for the image information of each dot which constitutes a polygon sequentially from the polygon located to the front to the display screen with an image formation means is performed. And a termination flag is memorized by the ending flag storage means about the dot which processing already ended. A processing dot directions means reads this termination flag from a termination flag storage means, and determines whether process that dot. And the termination flag of the dot which determined to process is returned to a termination flag storage means as a dot which processing newly ended. And it is directed that only the dot it was determined that will process to an image formation means performs said data processing. Thus, by operating, a false three-dimension image can be formed sequentially from the polygon before a screen, and it can go by this invention. Therefore, even if data processing stops meeting the deadline, it can prevent effectively that the data of the polygon before a screen lose. Furthermore, in this invention, after data processing of the polygon in this side, when performing data processing of the following polygon, about the part of a hidden surface, the termination flag is already written in. Therefore, data processing can be omitted about the part of this hidden surface, and improvement in the speed of processing can be attained.
[0022] Moreover, according to this invention, a processing dot directions means reads a termination flag for every two or more (N) dots, and can determine whether to be the dot which should process every two or more dots. Therefore, the part which is the hidden surface of the polygon in this side can be processed by skipping by N dot at the maximum. consequently,

compared with the case where it processes by only incrementing 1 dot at a time, it becomes possible to process by one times the speed of N at the maximum.
[0023] Moreover, according to this invention, it can judge with a mask pattern whether it is the dot surrounded by the right-and-left profile point. Moreover, it can judge with a termination flag whether it is the dot which processing already ended. And the dot which should process is a dot which processing has not yet ended among the dots surrounded by the right-and-left profile point. Therefore, in this invention, the dot which should process can be determined very simply by using this mask pattern and a termination flag.
[0024] Moreover, according to this invention, image composition using a polygon can be performed simply and a quality false three-dimension image can also be further compounded on real time using the texture-mapping technique.
[0025]
[Example]
(1) The image synthesizer unit of the explanation example of the whole equipment is constituted including a control unit 12, the game space operation part 13, the image composition section 1, and CRT46, as shown in drawing 1 . Moreover, the image composition section 1 is constituted including the image feed zone 10 and the image formation section 28. In addition, the following explanation explains this image synthesizer unit taking the case of the case where it applies to a three-dimension game.
[0026] A setup of game space is performed in the game space operation part 13 by the game program stored in the central-process section 14, and the actuation signal from a control unit 12. The game space setting information specifically constituted by the location and direction information on the three-dimension objects (for example, an enemy airplane, a crest, a building, etc.) which constitute game space, a location, line-of-sight information of a player, etc. calculates, and it is outputted to the image feed zone 10 in the image composition section 1.
[0027] In the image feed zone 10, predetermined data processing is performed according to the aforementioned game space setting information. Data processing, such as coordinate transformation from an absolute coordinate system to view system of coordinates, clipping processing, transparent transformation, and sorting processing, is performed, and, specifically, data are outputted to the image formation section 28. In addition, the data outputted in this case are expressed as data divided for every polygon, and specifically consist of top-most-vertices image information, such as a display coordinate of each top-most vertices of a polygon, a texture coordinate, and accompanying information on other.
[0028] The image formation section 28 calculates the image information inside a polygon based on the top-most-vertices image information given for every top-most vertices of this polygon, and outputs this to CRT46.
[0029] Now, in the image synthesizer unit of this example, image composition is performed by the texture-mapping technique and the gouraud-shading technique, and the technique to call that image composition of the image of high quality should be carried out more more efficiently. Hereafter, the concept of such technique is explained briefly.
[0030] The concept of the texture-mapping technique is shown in drawing 2 .
[0031] When carrying out image composition of that by which the pattern of the shape of the shape for example, of a grid and stripes etc. was given to each field of the three-dimension object 300 as shown in drawing 2 , it is a three-dimension polygon (1) about a three-dimension object conventionally. – (80) and (three-dimension polygon (41) It divided into – (not shown about 80)), and the image processing was performed to all these polygons. The reason is because only one specified color performed continuous tone of the color in one polygon in the conventional image synthesizer unit. Consequently, since the number of polygons increased very much in compounding the quality image with which the complicated pattern etc. was given, it was impossible substantially to have compounded the image of such high quality.
[0032] So, in this image synthesizer unit, processing of coordinate transformation, such as rotation of the three-dimension object 300, advancing side by side, and transparent transformation, clipping, etc. is performed for every three-dimension polygons A, B, and C which constitute each field (every [Specifically] top-most vertices of a 3-dimensional each polygon),

it is dealt with as a texture and the pattern of the shape of the shape of a grid and stripes is processed by dividing with processing of a polygon. That is, as shown in drawing 1 , the texture information storage section 42 is formed in the image formation section 28, and in this, image information, such as a pattern of the shape of the texture information which should be stuck on a 3-dimensional each polygon, the shape of i.e., a grid, and stripes, is memorized.
[0033] And they are the texture coordinates VTX and VTY of each top-most vertices of a 3-dimensional each polygon about the address of the texture information storage section 42 which specifies this texture information. It gives by carrying out. As shown in drawing 2 , specifically to each top-most vertices of Polygon A, the texture coordinate of (VTX0, VTY0), (VTX1, VTY1), (VTX2, VTY2), and (VTX3, VTY3) is set up.
[0034] the image formation section 28 — texture coordinates VTX and VTY of each of these top-most vertices from — the texture coordinate TX about all the dots in a polygon, and TY It asks. And the texture coordinate TX searched for and TY The texture information which corresponds from the texture information storage section 22 is read, and it becomes possible to carry out image composition of the three-dimension object to which textures, such as the shape of the shape of a grid as shown in drawing 2 , and stripes, were given.
[0035] According to the above technique, the throughput of data can be reduced sharply. Consequently, it becomes the optimal configuration for the image synthesizer unit which carries out a quality image processing to real time.
[0036] Moreover, in this image synthesizer unit, as described above, the three-dimension object 300 is expressed as a lump of a three-dimension polygon. Therefore, the continuity of the brightness information in the boundary of a 3-dimensional each polygon poses a problem. For example, if all the dots of all in a three-dimension polygon are set as the same brightness when it is going to express a ball using two or more three-dimension polygons, the situation where the boundary of a 3-dimensional each polygon is not expressed as a "radius of circle" although he wants to express a "radius of circle" in practice will arise. So, in this image synthesizer unit, this is avoided by the technique called gouraud shading. Like the texture-mapping technique described above by this technique, as shown in each top-most vertices of a three-dimension polygon at drawing 2 , they are the brightness information VBRI0 of each top-most vertices - VBRI3. In case it gives and image display is finally carried out in the image formation section 28, they are the brightness information VBRI0 of each of these top-most vertices - VBRI3. The brightness information about all the dots in a three-dimension polygon is searched for with interpolation. If it does in this way, while the problem of the above mentioned "radius of circle" is solvable, the amount of data processing needed within an image synthesizer unit can be reduced. Therefore, it becomes the optimal configuration for the image synthesizer unit which carries out a quality image processing to real time.
(2) The following processings are performed in the image feed zone image feed zone 10. That is, the processing section 15 reads first the image information of the three-dimension object which should be arranged to game space from the three-dimension image information storage section 16. Next, the processing section 15 includes a location and direction information in the image information of this three-dimension object, and is outputted to the coordinate transformation section 18. Then, in the coordinate transformation section 18, coordinate transformation is performed from an absolute coordinate system to view system of coordinates. Next, in the clipping processing section 19, the transparent transformation section 20, and the sorting processing section 22, clipping processing, transparent transformation, and sorting processing are performed, respectively. And the top-most-vertices image information of the polygon which processing ended is outputted to the image formation section 28.
[0037] Now, in the sorting processing section 22, data processing which rearranges the output order of the top-most-vertices image information of a polygon according to predetermined priority is performed. Specifically in the sorting processing section 22, it will be outputted sequentially from the top-most-vertices image information of the polygon which is in this side more to the display screen. Therefore, data processing in the image formation section 28 will be performed sequentially from the polygon which is in this side more.
[0038] Thus, since data processing in the image formation section 28 is performed sequentially

from a front polygon to the display screen, even if data processing stops this example being of use like the conventional example, possibility that the data of a front polygon will lose decreases very much. Moreover, since the data lost in this case serve as a polygon which is in a back side more to the display screen, there is very little effect which it has on the vision of a player. Therefore, it becomes possible to generate a more nearly quality image.
(3) The image formation section image formation section 28 has the function to calculate the image information of all the dots inside a three-dimension polygon, from the top-most-vertices image information of the polygon inputted according to predetermined sequence from the sorting processing section 22. Hereafter, the outline of actuation of the image formation section 28 is explained.
[0039] First, the sequential input of the top-most-vertices image information of a polygon, i.e., the display coordinate of each top-most vertices of a polygon, a texture coordinate, the brightness information, etc. is carried out from the sorting processing section 22 at the processor section 30. Moreover, data common to all the data in a polygon are inputted into the attribute RAM section 38 as attribute data.
[0040] In the processor section 30, the display coordinate of all the dots in a polygon, the texture coordinate TX, TY, and brightness information BRI are searched for from the display coordinate of each of these top-most vertices, a texture coordinate, brightness information, etc. And this texture coordinate TX searched for, TY, and brightness information BRI are written in the field buffer section 40 by making the above mentioned display coordinate into the address.
[0041] Now, the processing dot directions section 37 and the termination flag storage section 36 are connected to the main processor 32. This processing dot directions section 37 and the termination flag storage section 36 are used in order to omit data processing of the dot which data processing already ended and has been smeared away. This becomes possible to mitigate the burden of subsequent data processing very much. In addition, about the detail of this processing dot directions section 37 and the termination flag storage section 36, it mentions later.
[0042] In case image display is carried out, they are this FIRUDO buffer section 40 to the texture coordinates TX and TY. It is read and texture information is read from the texture storage section 42 by making this into the address. And from this information and the attribute data from the attribute RAM section 38, RGB data will be formed in the pallet & mixer circuit 44, and an image output will be carried out through CRT46.
[0043] The outline of data processing performed in the image formation section 28 is visually shown in drawing 3 . As already stated, in the image formation section 28, data processing which forms all the image information in a polygon is performed based on the top-most-vertices image information of a polygon. In this case, the texture information which should be stuck on a polygon is the texture coordinate TX and TY, in order for the texture information storage section 42 to memorize and to read this texture information. It is needed. And in drawing 3 (F), (G), (H), and (I), they are all transparent transformation texture coordinate TX * in a polygon, and TY *. The situation of data processing for which it asks is shown visually. This data processing is performed in a co-processor 34. Moreover, transparent transformation display coordinate X* which is the coordinate which should display texture information on drawing 3 (B), (C), (D), and (E) and Y* The situation of data processing for which it asks is shown visually. This data processing is performed in a main processor 32. And it calculates, as shown in drawing 3 (J), and they are **** transparent transformation texture coordinate TX * and TY *. The texture coordinate TX and TY Reverse transparent transformation is carried out and they are this texture coordinate TX by which reverse transparent transformation was carried out, and TY. Texture information is read from the texture information storage section 42. X* finally calculated as shown in drawing 3 (K), and Y* Image composition will be performed by matching the texture information read to the coordinate location. The outline of data processing performed to below at each step of drawing 3 (A) - (K) is explained.
[0044] It sets to drawing 3 (A) and they are the texture coordinate VTa, VTb, VTc, and VTd to the top-most vertices of a polyhedron 48, for example, A, B, C, and D. It is matched. This top-most-vertices texture coordinate VTa -VTd The address of the texture information stuck on the

polygon formed of top-most-vertices A-D is specified. That is, speaking concretely, being the texture coordinate which specifies the address for reading the texture information memorized by the storage means in the texture information storage section 42.
[0045] It sets to drawing 3 (B) and (F), and they are display coordinate A-D of each of these top-most vertices, and texture coordinate VTa -VTd. Transparent transformation coordinate A* of each top-most vertices - D*, and transparent transformation texture coordinate VTa * - VTd * Transparent transformation is carried out. Thereby, they are not only XY system of coordinates but Tx, and TY. Transparent transformation also of the system of coordinates will be carried out, and the linearity between each system of coordinates will be maintained.
[0046] Next, as shown in drawing 3 (C) and (G), they are transparent transformation coordinate A* of each top-most vertices - D*, and transparent transformation texture coordinate VTa * - VTd *. The linear interpolation operation of the profile point of the polygon formed is carried out. Namely, right-and-left profile point coordinate L* in drawing 3 (D) and (H), R* and right-and-left profile point texture coordinate Tl *, and Tr * A linear interpolation operation is performed.
[0047] Next, as shown in drawing 3 (D) and (H), they are said right-and-left profile point coordinate L*, R* and right-and-left profile point texture coordinate Tl *, and Tr *. The linear interpolation operation of the coordinate of each dot on the scanning line which connects these right-and-left profile points is carried out.
[0048] The above-mentioned data processing of drawing 3 (C), (G) and (D), and (H) is transparent transformation display coordinate X* of all the dots that constitute a polygon as it is repeated successively and is finally shown in drawing 3 (E) and (I), and Y*. And transparent transformation texture coordinate Tx * and TY* A linear interpolation operation is performed.
[0049] Next, as shown in drawing 3 (J), they are transparent transformation texture coordinate TX * and TY *. The texture coordinate TX and TY Reverse transparent transformation is carried out and they are this texture coordinate TX and TY. It uses and a color code is read from the above mentioned texture information storage section 42.
[0050] It is the color code read as mentioned above Transparent transformation display coordinate X* and Y* It is made to correspond. Thereby, as shown in drawing 3 (K), an image is compounded on a screen and texture mapping by which depth perception and linearity are not spoiled becomes possible.
[0051] In addition, in drawing 3 , it is transparent transformation display coordinate Z*. They are TX [in / in both operation / drawing 3] although the operation approach of a coordinate and brightness information BRI is not shown, and TY. It is carried out by the operation approach and the almost same operation approach.
(4) A false three-dimension image as finally shown in drawing 4 is formed the termination flag storage section, the processing dot directions section, now by calculating the image information of each polygon as mentioned above, and carrying out image composition of this. In this case, in drawing 4 , it is not necessary to carry out image display about the part which hides in a vehicle 590 among the paths 592 which are beyond [long distance] visible, and is not visible. It is not necessary to carry out image display also about the part which similarly hides in the house 594 which is in front among houses 596, and is not visible. Therefore, it is necessary to remove such a part, i.e., a hidden surface part. In this case, the image synthesizer unit of this example is formed so that data processing may be performed sequentially from the polygon which is in the near side of the display screen as already stated. Therefore, as shown in drawing 5 , to perform data processing about Polygon A first and then perform data processing about Polygon B, it is necessary to omit data processing about the parts of (the polygon A is in a near side from Polygon B), and C. For this reason, in this example, the termination flag storage section 36 and the processing dot directions section 37 are formed.
[0052] The storage flat surface in this termination flag storage section 36 supports the dot of the display screen 1 to 1. And the data called a termination flag by 1 bitwise corresponding to each dot are memorized. Here, a termination flag means the flag used in order to indicate whether data processing of each dot was completed. For example, about the dot which data processing ended among the dots which constitute the polygon A of drawing 5 , it is "1", for example. It is written in by the processing dot directions section 37. And in case data processing

is performed about Polygon B next, the processing dot directions section 37 is always acting as the monitor of this termination flag, and this termination flag is "1". It is made not to perform data processing about a dot which has become. It becomes unnecessary to perform data processing of the polygon about the already smeared-away field after that by this, and large improvement in the speed of processing speed can be attained.
[0053] The block diagram showing the connection relation between the processing dot directions section 37 and the termination flag storage section 36 is shown in drawing 6 . As shown in this drawing, the processing dot directions section 37 is vacant with the termination flag decision section 248, and is constituted including the dot detection loop formation 282.
[0054] The termination flag decision section 248 has the function to determine the dot which needs to process in the processor section 30. The termination flag of a dot with which having processed was determined is reset up by this termination flag decision section 248 as a dot which processing newly ended, and is returned to the termination flag storage section 36. And since these directions and write return are performed every two or more dots, large improvement in the speed of processing can be attained.
[0055] by the empty dot detection loop formation 282, it should process in the termination flag decision section 248 -- ** -- sequential detection of the determined dot is carried out. And X* of the dot which should process based on this detection result A coordinate is determined and it is outputted to the processor section 30.
[0056] The termination flag storage section 36 is constituted so that the "termination flag" for two screens can be memorized. A termination flag is remembered that 1 bit corresponds to 1 dot by the termination flag storage section 36. For this termination flag, all for one screen are "0" to the beginning of processing of one screen. It is cleared. And it is "1" after data processing is completed. It will be set and will indicate that data processing of the dot to which its attention is paid was completed.
[0057] The termination flag storage section 36 has a two or more bits, for example, 16 bits, data bus, and access of the data for 16 bits is possible for it to coincidence. And in the operation of a dot, this termination flag storage section 36 is always referred to. Therefore, it enables this to refer to a termination flag per 16 dots. and a termination flag -- "1" it is -- to a dot, the dot will not be calculated but the dot concerned will be skipped by 16 dots at a high speed, i.e., max. Therefore, it is X* when the dot on the polygon which should be calculated is hidden in the inner part of other polygons. High-speed processing of being about 16 times many as this can be expected [the case where only increment a coordinate and it is calculated].
[0058] In addition, in this example, the termination flag storage section 36 has 2 screen composition. This is for performing access to the termination flag storage section 36 accompanying the operation of a dot, and the clearance for said one screen in parallel.
[0059] Moreover, in here, it is the requisite for enabling improvement in the speed of processing that processing of a polygon is performed sequentially from a front thing.
[0060] Hereafter, the configuration and actuation are explained based on the block diagram of the termination flag storage section shown in drawing 6 .
[0061] First, X* of the left profile point generated by the termination flag decision section 248 by the operation of a profile point X* of a coordinate and a right profile point A coordinate is inputted. Here, each coordinate presupposes that it consists of 10-bit data, respectively. X* of this right profile point A coordinate is right profile point X*. The register 250 for coordinates memorizes. Moreover, left profile point X* 4 bits of low order among coordinates are left profile point X*. The register 252 for coordinate low order memorizes, and 6 bits of high orders are X*. It becomes the initial value for the count of the counter 254 for coordinate high orders. And the output of this counter 254 is profile point Y*. With a coordinate and a bank-switching signal, it will be inputted into the addresses A0-A14 of the termination flag storage section 36, and the address of the termination flag storage section 36 will be specified. That is, a counter 254 will count up said address every [every 4 bits and] 16 dots. By this, from the termination flag storage section 36, data, i.e., the termination flag group corresponding to 16 dots to which its attention is paid, will be read every 16 dots, and it will be memorized through the bidirectional buffer 262 by the register 264 for read-out.

[0062] what the mask pattern generating circuit 256 has inside a right-and-left profile point on the other hand among 16 dots to which its attention is paid — "1" ** — what carries out and is outside — "0" ** — it carries out — similarly the mask pattern in every 16 dots is generated. And the OR of said data memorized by OR circuit 258 for writing by the register 264 for read-out and this mask pattern is taken. Consequently, "an empty dot, i.e., the termination flag of a dot which it is newly going to process from now on," is "1". The updated write-in data will be generated. And after this write-in data is memorized by the register 260 for writing, it is returned to the termination flag storage section 36 through the bidirectional buffer 262. The data of 16 dots to which this pays its attention among the data of the termination flag memorized in the termination flag storage section 36 will be updated.
[0063] On the other hand, this mask pattern is reversed in an inverter circuit 266, and the data and the OR which were memorized by OR circuit 270 for read-out by the register 264 for read-out are taken. Consequently, the dot in which the outside dot and other outside polygons of a right-and-left profile point already exist is "1". It becomes and only an empty dot is "0". The becoming data will be generated. Suppose that this is temporarily called "empty dot data" here. These empty dot data are inputted into the empty dot detection loop formation 282.
[0064] In the empty dot detection loop formation 282, a multiplexer 292 incorporates said empty dot data, only when initializing the register 274 for continuous tone, and when other, it is constituted so that the data from a feedback loop may be incorporated. A self-loop formation will be formed by this. The empty dot data memorized by the register 274 for continuous tone are inputted into a priority encoder 276. This priority encoder 276 is X* most among empty dots. The value of a coordinate detects a small dot and outputs this as 4-bit data. And X* of an empty dot X* of the dot which should perform a coordinate, i.e., data processing, A coordinate is X* to the high order of this 4-bit data. It will be formed by adding 6 bit data from the coordinate high order counter 254.
[0065] The output of a priority encoder 276 is inputted into a decoder 280, and "the data with which only the dot to which its attention is paid is set to "1"" is generated in this decoder 280. An OR is taken for this data and the output of the register 274 for continuous tone by OR circuit 278, and "the data with which only the dot to which its attention is paid among empty dot data was updated by "1"" is generated. This updating data is returned to the continuous tone register 279 through a multiplexer 272. A series of actuation in this empty dot detection loop formation 282 is continued until the contents of the continuous tone register 274 become all the bits 1.
[0066] After actuation within the empty dot detection loop formation 282 is completed, the data of 16 dots as follows are read by count-up of a counter 254 from the termination flag storage section, and the above-mentioned processing is repeated.
[0067] And if it was detected and included in data of 16 dots whether the right profile point is included, from the next processing, it is X* of a new right-and-left profile point. A coordinate will be inputted and processing will be repeated.
[0068] In addition, the block diagram of the mask pattern generating circuit 256 is shown in drawing 7 . As shown in this drawing, the mask pattern generating circuit 256 is constituted including a comparator 284, OR circuits 286 and 292, the left mask pattern generating circuit 288, and the right mask pattern 290. Hereafter, actuation of this mask pattern generating circuit 256 is explained briefly.
[0069] In the left mask pattern generating circuit 288, it is left profile point X*. 4 bits of low order of a coordinate are inputted. And the left mask pattern generating circuit 288 is all the dots on the right of the dot and this which are specified among 16 dots of the beginning including a left profile point by 4 bits of this low order "1" The mask pattern to carry out is generated. Next, processing progresses, and after the first processing including a left profile point of 16 dots is completed, the contents of the register 252 are cleared. Then, the left mask pattern generating circuit 288 is all the dots that are cleared by this and process henceforth "1" The mask pattern of 16 dots to carry out is generated. As mentioned above, from the left mask pattern generating circuit 288, it is left profile point X*. It is "1" in all the dots on the right of a coordinate. The left mask pattern to carry out will be generated.
[0070] X* of the dot under processing which is the output of a counter 254 6 bits of high orders

and right profile point X* of a coordinate 6 bits of high orders of a coordinate are always compared by the comparator circuit 284. And a comparator circuit 284 is the output of a counter 254, and right profile point X*. It is "1" until 6 bits of high orders of a coordinate are in agreement. It outputs, this output minds OR circuit 286, and it is "1". It becomes and is inputted into the right mask pattern generating circuit 290. [4-bit] By this, the right mask pattern generating circuit 290 will output "1" of 16 dots. When the last processing including a right profile point of 16 dots is started, the output of a comparator circuit 284 is "0". In order to change, in the right mask pattern generating circuit 290, it is right profile point X*. 4 bits of low order of a coordinate input through OR circuit 286. And the right mask pattern generating circuit 290 is all the dots on the left of the dot and this which are specified among 16 dots of the last including a right profile point by 4 bits of this low order "1" The mask pattern to carry out is generated. As mentioned above, from the right mask pattern generating circuit 290, it is right profile point X*. It is "1" in all the dots on the left of a coordinate. The right mask pattern to carry out will be generated.

[0071] The left mask pattern from these left mask pattern generating circuits 288 and the right mask pattern from the right mask pattern generating circuit 290 are inputted into AND circuit 292. Thereby, it is left profile point X*. Coordinate and right profile point X* Only the part surrounded by the coordinate is "1". The becoming mask pattern will be generated.

[0072] Next, the processing sequence chart showing actuation of the above processing dot directions section 37 and the termination flag 36 in drawing 8 explains. In addition, hereafter, in order to simplify explanation, the coordinate of a left profile point and a right profile point shall presuppose that it consists of 8 bits, and processing with a termination flag shall be performed every 4 dots. Therefore, the number of bits of each data bus in drawing 6 and drawing 7 turns into drawing 6 and the number of bits shown in the parenthesis of drawing 7 in this case. Moreover, Polygon K is already drawn and drawing 8 shows the case where Polygon L is drawn on this in piles. And since the direction of Polygon K is located toward a screen in [Polygon / L] this case in this side, the need of omitting continuous tone processing between MN(s) of drawing 8 arises.

[0073] First, left profile point X* Coordinate and right profile point X* A coordinate is inputted into registers 250 and 252 and a counter 254. In this case, left profile point X* It is (00000010) and right profile point X* as a coordinate. Suppose that 8 bit data of (00010000) were inputted as a coordinate. Then, as shown at the phase A of drawing 8 R> 8, the initial value of a counter 254 is left profile point X*. It is set as 6 bits (000000) of high orders of a coordinate. And the output of this counter 254 is inputted into the termination flag storage section 36, and the termination flag of 4 dots to which its attention is paid is read. Since Polygon K is already drawn in the example shown in drawing 8 here, in the termination flag storage section 36, between MN is "1". The becoming termination flag is memorized. However, there is no lap of a between [4 dots to which its attention is paid, and MN]. therefore, the phase A — setting (0000) — the becoming termination flag will be read and this termination flag will be memorized by the register 264 through the bidirectional buffer 262.

[0074] On the other hand, in the left mask pattern generating circuit 288 shown in drawing 7 , it is left profile point X*. 2 bits (10) of low order of a coordinate are inputted, and, thereby, 2 dots of Phase A or subsequent ones are "1". The becoming left mask pattern will be generated. Moreover, in a comparator circuit 284, they are the output (000000) of a counter 254, and right profile point X*. Since 6 bits (000100) of high orders of a coordinate are inputted, it is judged that it is inharmonious, and it is "1". It is outputted. Consequently, from the right mask pattern generating circuit 290, they are all the dots of Phase A "1" The right mask pattern to carry out is generated. As mentioned above, as shown in drawing 8 from the mask pattern generating circuit 256, 2 dot or subsequent ones is "1". The becoming mask pattern will be generated.

[0075] Next, the output (0000) of this mask pattern (0011) and a register 264 is inputted into OR circuit 258, and an OR is taken. And the result of this OR is returned to the termination flag storage section 36 through a register 260 and the bidirectional buffer 262. Thereby, the termination flag of 4 dots to which its attention is paid is rewritten from (0000) to (0011). Consequently, about 2 dots of right-hand side in these 4 dots, the continuous tone in future data

processing will be forbidden.
[0076] On the other hand, a mask pattern (0011) is reversed in an inverter circuit 266, and an OR with the output (0000) of a register 264 is taken. Data [thereby / (1100)] are memorized by the register 274 through a multiplexer 272. In here, it will be shown that the semantics of the data (1100) is a dot without the need that "dots 0 and 1" smears away, and "dots 2 and 3" is dots (empty dot) with the need of smearing away.
[0077] With the ply cage encoder 276, it is X[among empty dots] *. The smallest dot of a coordinate is detected. In this example, a dot 2, i.e., the empty dot in the 3rd dot, is detected. And based on this detection result, the data of (10) in which the 3rd dot is vacant and it is shown that it is a dot are generated. And the data of (00000010) are formed of this data of (10), and the output (000000) of a counter 254, and it is outputted to the processor section 30. Thereby, at the processor section 30, it is X*. Data processing of the dot specified with a coordinate (000010) will be performed.
[0078] On the other hand, the output (10) of a priority encoder 276 is inputted into a decoder 280. And the data (0010) with which only the dot to which its attention is paid in a decoder 280 is set to 1 are generated. next, OR circuit 278 — setting — this (0010) — the OR of the output (1100) of data and a register 274 is taken, and data (1110) are returned to a register 274.
[0079] Next, in a priority encoder 276, the 4th dot is vacant, it is detected with a dot, and data generation of (11) is carried out. And X* A coordinate (00000011) is outputted to the processor section 30. Then, the data set to a decoder 280 (0001) are generated. And the OR of this data and the output (1110) of a register 274 is taken, data (1111) are generated, and it is returned to a register 274.
[0080] At a priority encoder 276, since it is vacant from the output (1111) of a register 274 and a dot is not detected, processing of Phase A will be completed at this time.
[0081] Next, the data which a counter 254 counts up (000001) are outputted in Phase B. Thereby, a termination flag (0001) is read from the termination flag storage section 36. Moreover, since a register 252 is cleared, the data of (1111) are outputted from the mask pattern generating circuit 256. consequently, a termination flag (1111) is returned — data (0001) are both memorized by the register 274.
[0082] Next, by the empty dot detection loop formation 282, detection of an empty dot is performed until the stored data of a register 274 is set to (1111) from (0001), as shown in drawing 8 . And X* A coordinate (00000100), (00000101), and (00000110) will be outputted to the processor section 30 one after another. If the stored data of a register 274 is set to (1111), it will shift to Phase C.
[0083] All the dots that should be processed in Phase C are dots already smeared away by Polygon K. Therefore, a termination flag is set to (1111) and processing by the empty dot detection loop formation will be performed. Thereby, large improvement in the speed of processing can be attained.
[0084] The dot which should be processed from the 14th dot starts in Phase D. Therefore, from the processing dot directions section 37, it is X*. A coordinate (00001110) and (00001111) will be outputted to the processor section 30 one by one.
[0085] In Phase E, it becomes the dot of the outside of Polygon L after 17 dot. Therefore, a right mask pattern is set to (1000) and a mask pattern is also set to (1000). Consequently, data, i.e., right profile point X, * of the 16th dot Only a coordinate (00010000) will be outputted to the processor section 30.
[0086] By this example, effective hidden surface removal which is not in the former can be performed as mentioned above by having the processing dot directions section 37 and the termination flag storage section 36. That is, according to this example, data processing is performed from the polygon which is in a near side to the display screen. Therefore, even if data processing stops meeting the deadline, the data of the polygon in a near side hardly lose. And though it draws a front in this way and being considered as preferential hardware, efficient hidden surface removal can be performed very much by making the termination flag storage section 36 memorize a termination flag at high speed. And since the data memorized by the termination flag storage means 36 are for example, 1 bit data, there is also very little data

volume of the termination flag storage means 36, and they can be carried out. Moreover, since the processing dot directions section 37 can perform decision of whether to process every two or more dots, it can be processed very much at a high speed.
[0087] Furthermore, at this example, since it is processing by introducing the concept of a mask pattern and a termination flag, hidden surface removal can be performed with a very simple configuration. When determining the dot which should process every two or more dots, what is necessary will be just to process this mask pattern and a termination flag every two or more dots by this example especially. Consequently, the image synthesizer unit concerning this example serves as configuration optimal as an image synthesizer unit which can determine the dot which should be processed every two or more dots.
[0088] In addition, this invention is not limited to the above-mentioned example, and deformation implementation various by within the limits of the summary of this invention is possible for it.
[0089] For example, although this example explained to the example the image composition which sticks a texture on a polygon by the texture-mapping technique, this invention is applicable to not only this but all kinds of the image composition technique. For example, the block diagram of the example at the time of carrying out image composition using the polygon generator 322 is shown in drawing 9 . In this example, the profile point operation part 324 and the Rhine processor 326 are built in the polygon generating circuit 322. The profile point operation part 324 asks for the image information in a right-and-left profile point from image information, such as each top-most-vertices ********** coordinate information on a polygon, and color information. And the Rhine processor 326 will smear away the dot on the scanning line which connects a right-and-left profile point using predetermined color information from the image information of this right-and-left profile point. In this Rhine processor 326, the processing for every scanning line is a high order from the processing for every polygon contrary to the previous example. Namely, between the right-and-left profile points of all the polygons on this scanning line is smeared away for every scanning line. Thus, if constituted, the termination flag storage section 36 will end by the capacity for the 1 scanning line.
[0090]
[Effect of the Invention] Since the termination flag is already written in about the part of a hidden surface when performing data processing of the following polygon after data processing of the polygon in this side while according to this invention being able to form a false three-dimension image sequentially from the polygon before a screen and being able to go, about the part of this hidden surface, data processing is omissible. Therefore, even if data processing stops meeting the deadline, while being able to prevent effectively that the data of the polygon before a screen lose, large improvement in the speed of processing can be attained. since especially this invention judges that it is a hidden surface using few termination flags of the amount of data, processing of it is possible for a high speed — the storage capacity of a storage means can both also be saved.
[0091] Moreover, according to this invention, the part which is the hidden surface of the polygon in this side can be processed by skipping by N dot at the maximum. consequently, compared with the case where it processes by only incrementing 1 dot at a time, it becomes possible to process by one times the speed of N at the maximum.
[0092] Moreover, according to this invention, the dot which should process can be determined very simply by using a mask pattern and a termination flag. When determining especially the dot which should process every two or more dots according to this invention, what is necessary will be just to process a mask pattern and an ending flag every two or more dots. Consequently, this invention using a mask pattern and a termination flag serves as optimal configuration as an image synthesizer unit which can determine the dot which should be processed every two or more dots.
[0093] Moreover, according to this invention, a false three-dimension image [that it is quality and real time] is compoundable with a simpler configuration using a polygon or the texture-mapping technique.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] This invention relates to an image synthesizer unit and the image synthesizer unit which can carry out quality image composition to real time.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Various things are known as an image synthesizer unit used for the operation simulator of the conventional, for example, three dimension, game or an airplane, and various vehicles etc. In such an image synthesizer unit, the image information about the three-dimension body 300 shown in drawing 10 is beforehand memorized by equipment. And image display of the false three-dimension image 308 is carried out on the screen 306 by carrying out transparent transformation of this image information on a screen 306. If a player 302 operates rotation, advancing side by side, etc. with a control panel 304, equipment will carry out data processing, such as rotation, advancing side by side, etc. to the three-dimension body 300, to real time based on this actuation signal. Then, transparent transformation of the three-dimension image with which data processing, such as this rotation, was performed is carried out on a screen 306, and a false three-dimension image is displayed. Consequently, a player 302 becomes possible [that rotation advancing side by side, etc. make the three-dimension body 300 real time by own actuation], and can carry out the virtual experience of the imagination three-dimension space.
[0003] An example of the configuration of such an image synthesizer unit is shown in drawing 11 . In addition, in the following explanation, explanation is advanced taking the case of the case where an image synthesizer unit is applied to a three-dimension game.
[0004] As shown in drawing 11 , this image synthesizer unit is constituted by a control unit 510, the game space operation part 500, the image composition section 512, and CRT518.
[0005] In the game space operation part 500, a setup of game space is performed according to the game program memorized by the actuation signal from a control unit 510, and the central-process section 506. That is, the operation of in which direction to arrange the three-dimension body 300 in which location is performed.
[0006] The image composition section 512 is constituted including the image feed zone 514 and the image formation section 516. And in the image composition section 512, image composition of a false three-dimension image is performed according to the setting information on the game space by the game space operation part 500.
[0007] Now, in this image synthesizer unit, the three-dimension body which constitutes game space is expressed as a polyhedron divided into the polygon of a three dimension. For example, it sets to drawing 12 and the three-dimension body 300 is the polygon (1) of a three dimension. - (6) (polygon (4) - (6) does not illustrate) It is expressed as a divided polyhedron. And a coordinate, accompanying data, etc. of each top-most vertices of this three dimension are memorized by the three-dimension image information storage section 552 (it is hereafter called top-most-vertices image information). [of a polygon]
[0008] In the image feed zone 514, various kinds of coordinate transformation, such as various kinds of operations, such as rotation, advancing side by side, etc. to this top-most-vertices image information, and transparent transformation, is performed according to the setting information on the game space operation part 500. And after the top-most-vertices image information which data processing ended is rearranged in predetermined sequence, it is outputted to the image formation section 516.
[0009] The image formation section 516 is constituted including the polygon generating circuit

570 and the pallet circuit 580, and the polygon generating circuit 570 is constituted including the profile point operation part 324 and the Rhine processor 326. In the image formation section 516, data processing which smears away all the dots inside a polygon by predetermined color data etc. is performed by the following procedures.

[0010] First, in the profile point operation part 324, the right-and-left profile point which is an intersection of the border lines AB, BC, CD, and DA of a polygon etc. and the scanning line calculates. Next, it is smeared away by the color data with which between LQ in the part surrounded by these right-and-left profile points, for example, drawing 12 , and between QR were specified by the Rhine processor 326. In drawing 12 , it is smeared away by blue color data between red and QR between LQ. Then, RGB conversion is carried out in the pallet circuit 580, and an output indication of this painted-out color data is given from CRT518.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] Since the termination flag is already written in about the part of a hidden surface when performing data processing of the following polygon after data processing of the polygon in this side while according to this invention being able to form a false three-dimension image sequentially from the polygon before a screen and being able to go, about the part of this hidden surface, data processing is omissible. Therefore, even if data processing stops meeting the deadline, while being able to prevent effectively that the data of the polygon before a screen lose, large improvement in the speed of processing can be attained. since especially this invention judges that it is a hidden surface using few termination flags of the amount of data, processing of it is possible for a high speed — the storage capacity of a storage means can both also be saved.
[0091] Moreover, according to this invention, the part which is the hidden surface of the polygon in this side can be processed by skipping by N dot at the maximum. consequently, compared with the case where it processes by only incrementing 1 dot at a time, it becomes possible to process by one times the speed of N at the maximum.
[0092] Moreover, according to this invention, the dot which should process can be determined very simply by using a mask pattern and a termination flag. When determining especially the dot which should process every two or more dots according to this invention, what is necessary will be just to process a mask pattern and an ending flag every two or more dots. Consequently, this invention using a mask pattern and a termination flag serves as optimal configuration as an image synthesizer unit which can determine the dot which should be processed every two or more dots.
[0093] Moreover, according to this invention, a false three-dimension image [that it is quality and real time] is compoundable with a simpler configuration using a polygon or the texture-mapping technique.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] By the way, when such a continuous tone activity is done and a polygon and a polygon lap, it is necessary to display on a screen only the part which sees from a view among polygons and is in a near side. For this reason, in the conventional image synthesizer unit, the technique smeared away one by one from the polygon which is in a back side to the display screen was taken.
[0012] however, with this kind of image synthesizer unit, it is required that an image processing should be carried out to real time, and it usually needs to update the image data for one screen (a case — depending — **** — two screens) every [every field 1 /] 60 seconds. Therefore, if the rapidity of an image processing is required of the image synthesizer unit concerned and this rapidity is not collateralized, image quality is made to fall to it as a result. And the processing part which carries out rate-limiting [of the rapidity of this image processing] most is a processing part which finally smears away each dot in a predetermined color, and goes.
[0013] However, in the conventional image synthesizer unit, the technique of having smeared away one by one and going from the polygon in the back side of the display screen, was taken. Therefore, finally the surface integral of all the polygons that appear in 1 field, and this continuous tone processing that starts most as for time amount had to be performed. However, the part in which the polygon and the polygon put each other and hid is a part which finally is not displayed on a screen, and it means that the conventional example had performed useless processing in this part. For this reason, the conventional image synthesizer unit had achievement of the technical technical problem that it processes at a high speed inadequate for real time.
[0014] Furthermore, when continuous tone of a color had to be performed from the polygon which is in the inner part of the display screen in this way, the number of polygons which should be displayed on a screen increases and the continuous tone processing of a color to a polygon is not completed during 1 field period, it will lose from the data of a front polygon. However, it is the polygon which usually looks good to a player as the polygon before a screen, and is the constitutionally most important polygon of a game. Therefore, it was not desirable that the data of such an important polygon lost, also when collateralizing the high quality nature of a screen.
[0015] This invention is made in view of the above conventional technical problems, and especially the place made into the purpose is to offer the optimal image synthesizer unit for carrying out an image processing to real time.

[Translation done.]

MEANS

[Means for Solving the Problem] The image synthesizer unit applied to this invention in order to attain said purpose It is the image synthesizer unit which carries out transparent transformation of the three-dimension image which consists of three-dimension polygons on predetermined plane of projection, and compounds a false three-dimension image. An image formation means to ask for the image information of each dot which constitutes a polygon sequentially from the polygon located to the front to the display screen based on each top-most-vertices image information of said polygon by which transparent transformation was carried out by predetermined data processing, A termination flag storage means by which the termination flag which shows termination of data processing to the address position corresponding to the dot which data processing by said image formation means ended is memorized, Read said termination flag from said termination flag storage means, and a processing dot directions means to direct the dot which should process based on this termination flag for said image formation means is included. While returning the termination flag of the dot which determined to process said processing dot directions means to said termination flag storage means as a dot which processing newly ended It is characterized by attaining improvement in the speed of processing by directing that only the dot which determined to process to said image formation means performs said data processing.
[0017] In this case, said termination flag is memorized by said termination flag storage means every two or more dots, said processing dot directions means reads this termination flag every two or more dots, and it is desirable to direct the dot which should determine the dot which should process based on the termination flag in every two or more read dots, and should be processed for said image formation means.
[0018] Moreover, said data processing in said image formation means is due to each top-most-vertices image information of the polygon by which transparent transformation was carried out in this case. The right-and-left profile point which is a point that the border line and each scanning line of a polygon cross is searched for. It is carried out by asking for the image information of each dot on the scanning line which connects this right-and-left profile point. Said processing dot directions means It is desirable to determine the dot which processing has not ended among the dots surrounded by the right-and-left profile point by using the mask pattern which directs that it is the dot surrounded by said right-and-left profile point, and said termination flag which directs that it is the dot which processing already ended.
[0019] Moreover, said image formation means can be constituted so that it may ask for the image information of each dot which constitutes said polygon by predetermined data processing based on the color information on said each polygon, and the display coordinate information on each top-most vertices.
[0020] Furthermore, said image formation means can also be considered as the configuration which asks for the image information of each dot which constitutes said polygon by predetermined data processing based on the display coordinate information and texture information of each top-most vertices on said polygon.

[Translation done.]

OPERATION

[Function] According to this invention, data processing which asks for the image information of each dot which constitutes a polygon sequentially from the polygon located to the front to the display screen with an image formation means is performed. And a termination flag is memorized by the ending flag storage means about the dot which processing already ended. A processing dot directions means reads this termination flag from a termination flag storage means, and determines whether process that dot. And the termination flag of the dot which determined to process is returned to a termination flag storage means as a dot which processing newly ended. And it is directed that only the dot it was determined that will process to an image formation means performs said data processing. Thus, by operating, a false three-dimension image can be formed sequentially from the polygon before a screen, and it can go by this invention. Therefore, even if data processing stops meeting the deadline, it can prevent effectively that the data of the polygon before a screen lose. Furthermore, in this invention, after data processing of the polygon in this side, when performing data processing of the following polygon, about the part of a hidden surface, the termination flag is already written in. Therefore, data processing can be omitted about the part of this hidden surface, and improvement in the speed of processing can be attained.

[0022] Moreover, according to this invention, a processing dot directions means reads a termination flag for every two or more (N) dots, and can determine whether to be the dot which should process every two or more dots. Therefore, the part which is the hidden surface of the polygon in this side can be processed by skipping by N dot at the maximum. consequently, compared with the case where it processes by only incrementing 1 dot at a time, it becomes possible to process by one times the speed of N at the maximum.

[0023] Moreover, according to this invention, it can judge with a mask pattern whether it is the dot surrounded by the right-and-left profile point. Moreover, it can judge with a termination flag whether it is the dot which processing already ended. And the dot which should process is a dot which processing has not yet ended among the dots surrounded by the right-and-left profile point. Therefore, in this invention, the dot which should process can be determined very simply by using this mask pattern and a termination flag.

[0024] Moreover, according to this invention, image composition using a polygon can be performed simply and a quality false three-dimension image can also be further compounded on real time using the texture-mapping technique.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EXAMPLE

[Example]
(1) The image synthesizer unit of the explanation example of the whole equipment is constituted including a control unit 12, the game space operation part 13, the image composition section 1, and CRT46, as shown in drawing 1 . Moreover, the image composition section 1 is constituted including the image feed zone 10 and the image formation section 28. In addition, the following explanation explains this image synthesizer unit taking the case of the case where it applies to a three-dimension game.
[0026] A setup of game space is performed in the game space operation part 13 by the game program stored in the central-process section 14, and the actuation signal from a control unit 12. The game space setting information specifically constituted by the location and direction information on the three-dimension objects (for example, an enemy airplane, a crest, a building, etc.) which constitute game space, a location, line-of-sight information of a player, etc. calculates, and it is outputted to the image feed zone 10 in the image composition section 1.
[0027] In the image feed zone 10, predetermined data processing is performed according to the aforementioned game space setting information. Data processing, such as coordinate transformation from an absolute coordinate system to view system of coordinates, clipping processing, transparent transformation, and sorting processing, is performed, and, specifically, data are outputted to the image formation section 28. In addition, the data outputted in this case are expressed as data divided for every polygon, and specifically consist of top-most-vertices image information, such as a display coordinate of each top-most vertices of a polygon, a texture coordinate, and accompanying information on other.
[0028] The image formation section 28 calculates the image information inside a polygon based on the top-most-vertices image information given for every top-most vertices of this polygon, and outputs this to CRT46.
[0029] Now, in the image synthesizer unit of this example, image composition is performed by the texture-mapping technique and the gouraud-shading technique, and the technique to call that image composition of the image of high quality should be carried out more more efficiently. Hereafter, the concept of such technique is explained briefly.
[0030] The concept of the texture-mapping technique is shown in drawing 2 .
[0031] When carrying out image composition of that by which the pattern of the shape of the shape for example, of a grid and stripes etc. was given to each field of the three-dimension object 300 as shown in drawing 2 , it is a three-dimension polygon (1) about a three-dimension object conventionally. - (80) and (three-dimension polygon (41) It divided into - (not shown about 80)), and the image processing was performed to all these polygons. The reason is because only one specified color performed continuous tone of the color in one polygon in the conventional image synthesizer unit. Consequently, since the number of polygons increased very much in compounding the quality image with which the complicated pattern etc. was given, it was impossible substantially to have compounded the image of such high quality.
[0032] So, in this image synthesizer unit, processing of coordinate transformation, such as rotation of the three-dimension object 300, advancing side by side, and transparent transformation, clipping, etc. is performed for every three-dimension polygons A, B, and C which

constitute each field (every [Specifically] top-most vertices of a 3-dimensional each polygon), it is dealt with as a texture and the pattern of the shape of the shape of a grid and stripes is processed by dividing with processing of a polygon. That is, as shown in drawing 1 , the texture information storage section 42 is formed in the image formation section 28, and in this, image information, such as a pattern of the shape of the texture information which should be stuck on a 3-dimensional each polygon, the shape of i.e., a grid, and stripes, is memorized.
[0033] And they are the texture coordinates VTX and VTY of each top-most vertices of a 3-dimensional each polygon about the address of the texture information storage section 42 which specifies this texture information. It gives by carrying out. As shown in drawing 2 , specifically to each top-most vertices of Polygon A, the texture coordinate of (VTX0, VTY0), (VTX1, VTY1), (VTX2, VTY2), and (VTX3, VTY3) is set up.
[0034] the image formation section 28 -- texture coordinates VTX and VTY of each of these top-most vertices from -- the texture coordinate TX about all the dots in a polygon, and TY It asks. And the texture coordinate TX searched for and TY The texture information which corresponds from the texture information storage section 22 is read, and it becomes possible to carry out image composition of the three-dimension object to which textures, such as the shape of the shape of a grid as shown in drawing 2 , and stripes, were given.
[0035] According to the above technique, the throughput of data can be reduced sharply. Consequently, it becomes the optimal configuration for the image synthesizer unit which carries out a quality image processing to real time.
[0036] Moreover, in this image synthesizer unit, as described above, the three-dimension object 300 is expressed as a lump of a three-dimension polygon. Therefore, the continuity of the brightness information in the boundary of a 3-dimensional each polygon poses a problem. For example, if all the dots of all in a three-dimension polygon are set as the same brightness when it is going to express a ball using two or more three-dimension polygons, the situation where the boundary of a 3-dimensional each polygon is not expressed as a "radius of circle" although he wants to express a "radius of circle" in practice will arise. So, in this image synthesizer unit, this is avoided by the technique called gouraud shading. Like the texture-mapping technique described above by this technique, as shown in each top-most vertices of a three-dimension polygon at drawing 2 , they are the brightness information VBRI0 of each top-most vertices - VBRI3. In case it gives and image display is finally carried out in the image formation section 28, they are the brightness information VBRI0 of each of these top-most vertices - VBRI3. The brightness information about all the dots in a three-dimension polygon is searched for with interpolation. If it does in this way, while the problem of the above mentioned "radius of circle" is solvable, the amount of data processing needed within an image synthesizer unit can be reduced. Therefore, it becomes the optimal configuration for the image synthesizer unit which carries out a quality image processing to real time.
(2) The following processings are performed in the image feed zone image feed zone 10. That is, the processing section 15 reads first the image information of the three-dimension object which should be arranged to game space from the three-dimension image information storage section 16. Next, the processing section 15 includes a location and direction information in the image information of this three-dimension object, and is outputted to the coordinate transformation section 18. Then, in the coordinate transformation section 18, coordinate transformation is performed from an absolute coordinate system to view system of coordinates. Next, in the clipping processing section 19, the transparent transformation section 20, and the sorting processing section 22, clipping processing, transparent transformation, and sorting processing are performed, respectively. And the top-most-vertices image information of the polygon which processing ended is outputted to the image formation section 28.
[0037] Now, in the sorting processing section 22, data processing which rearranges the output order of the top-most-vertices image information of a polygon according to predetermined priority is performed. Specifically in the sorting processing section 22, it will be outputted sequentially from the top-most-vertices image information of the polygon which is in this side more to the display screen. Therefore, data processing in the image formation section 28 will be performed sequentially from the polygon which is in this side more.

[0038] Thus, since data processing in the image formation section 28 is performed sequentially from a front polygon to the display screen, even if data processing stops this example being of use like the conventional example, possibility that the data of a front polygon will lose decreases very much. Moreover, since the data lost in this case serve as a polygon which is in a back side more to the display screen, there is very little effect which it has on the vision of a player. Therefore, it becomes possible to generate a more nearly quality image.
(3) The image formation section image formation section 28 has the function to calculate the image information of all the dots inside a three-dimension polygon, from the top-most-vertices image information of the polygon inputted according to predetermined sequence from the sorting processing section 22. Hereafter, the outline of actuation of the image formation section 28 is explained.
[0039] First, the sequential input of the top-most-vertices image information of a polygon, i.e., the display coordinate of each top-most vertices of a polygon, a texture coordinate, the brightness information, etc. is carried out from the sorting processing section 22 at the processor section 30. Moreover, data common to all the data in a polygon are inputted into the attribute RAM section 38 as attribute data.
[0040] In the processor section 30, the display coordinate of all the dots in a polygon, the texture coordinate TX, TY, and brightness information BRI are searched for from the display coordinate of each of these top-most vertices, a texture coordinate, brightness information, etc. And this texture coordinate TX searched for, TY, and brightness information BRI are written in the field buffer section 40 by making the above mentioned display coordinate into the address.
[0041] Now, the processing dot directions section 37 and the termination flag storage section 36 are connected to the main processor 32. This processing dot directions section 37 and the termination flag storage section 36 are used in order to omit data processing of the dot which data processing already ended and has been smeared away. This becomes possible to mitigate the burden of subsequent data processing very much. In addition, about the detail of this processing dot directions section 37 and the termination flag storage section 36, it mentions later.
[0042] In case image display is carried out, they are this FIRUDO buffer section 40 to the texture coordinates TX and TY. It is read and texture information is read from the texture storage section 42 by making this into the address. And from this information and the attribute data from the attribute RAM section 38, RGB data will be formed in the pallet & mixer circuit 44, and an image output will be carried out through CRT46.
[0043] The outline of data processing performed in the image formation section 28 is visually shown in drawing 3 . As already stated, in the image formation section 28, data processing which forms all the image information in a polygon is performed based on the top-most-vertices image information of a polygon. In this case, the texture information which should be stuck on a polygon is the texture coordinate TX and TY, in order for the texture information storage section 42 to memorize and to read this texture information. It is needed. And in drawing 3 (F), (G), (H), and (I), they are all transparent transformation texture coordinate TX * in a polygon, and TY *. The situation of data processing for which it asks is shown visually. This data processing is performed in a co-processor 34. Moreover, transparent transformation display coordinate X* which is the coordinate which should display texture information on drawing 3 (B), (C), (D), and (E) and Y* The situation of data processing for which it asks is shown visually. This data processing is performed in a main processor 32. And it calculates, as shown in drawing 3 (J), and they are **** transparent transformation texture coordinate TX * and TY *. The texture coordinate TX and TY Reverse transparent transformation is carried out and they are this texture coordinate TX by which reverse transparent transformation was carried out, and TY. Texture information is read from the texture information storage section 42. X* finally calculated as shown in drawing 3 (K), and Y* Image composition will be performed by matching the texture information read to the coordinate location. The outline of data processing performed to below at each step of drawing 3 (A) - (K) is explained.
[0044] It sets to drawing 3 (A) and they are the texture coordinate VTa, VTb, VTc, and VTd to the top-most vertices of a polyhedron 48, for example, A, B, C, and D. It is matched. This top-

most-vertices texture coordinate VTa -VTd The address of the texture information stuck on the polygon formed of top-most-vertices A-D is specified. That is, speaking concretely, being the texture coordinate which specifies the address for reading the texture information memorized by the storage means in the texture information storage section 42.

[0045] It sets to drawing 3 (B) and (F), and they are display coordinate A-D of each of these top-most vertices, and texture coordinate VTa -VTd. Transparent transformation coordinate A* of each top-most vertices - D*, and transparent transformation texture coordinate VTa * - VTd * Transparent transformation is carried out. Thereby, they are not only XY system of coordinates but Tx, and TY. Transparent transformation also of the system of coordinates will be carried out, and the linearity between each system of coordinates will be maintained.

[0046] Next, as shown in drawing 3 (C) and (G), they are transparent transformation coordinate A* of each top-most vertices - D*, and transparent transformation texture coordinate VTa * - VTd *. The linear interpolation operation of the profile point of the polygon formed is carried out. Namely, right-and-left profile point coordinate L* in drawing 3 (D) and (H), R* and right-and-left profile point texture coordinate Tl *, and Tr * A linear interpolation operation is performed.

[0047] Next, as shown in drawing 3 (D) and (H), they are said right-and-left profile point coordinate L*, R* and right-and-left profile point texture coordinate Tl *, and Tr *. The linear interpolation operation of the coordinate of each dot on the scanning line which connects these right-and-left profile points is carried out.

[0048] The above-mentioned data processing of drawing 3 (C), (G) and (D), and (H) is transparent transformation display coordinate X* of all the dots that constitute a polygon as it is repeated successively and is finally shown in drawing 3 (E) and (I), and Y*. And transparent transformation texture coordinate Tx * and TY* A linear interpolation operation is performed.

[0049] Next, as shown in drawing 3 (J), they are transparent transformation texture coordinate TX * and TY *. The texture coordinate TX and TY Reverse transparent transformation is carried out and they are this texture coordinate TX and TY. It uses and a color code is read from the above mentioned texture information storage section 42.

[0050] It is the color code read as mentioned above Transparent transformation display coordinate X* and Y* It is made to correspond. Thereby, as shown in drawing 3 (K), an image is compounded on a screen and texture mapping by which depth perception and linearity are not spoiled becomes possible.

[0051] In addition, in drawing 3 , it is transparent transformation display coordinate Z*. They are TX [in / in both operation / drawing 3] although the operation approach of a coordinate and brightness information BRI is not shown, and TY. It is carried out by the operation approach and the almost same operation approach.

(4) A false three-dimension image as finally shown in drawing 4 is formed the termination flag storage section, the processing dot directions section, now by calculating the image information of each polygon as mentioned above, and carrying out image composition of this. In this case, in drawing 4 , it is not necessary to carry out image display about the part which hides in a vehicle 590 among the paths 592 which are beyond [long distance] visible, and is not visible. It is not necessary to carry out image display also about the part which similarly hides in the house 594 which is in front among houses 596, and is not visible. Therefore, it is necessary to remove such a part, i.e., a hidden surface part. In this case, the image synthesizer unit of this example is formed so that data processing may be performed sequentially from the polygon which is in the near side of the display screen as already stated. Therefore, as shown in drawing 5 , to perform data processing about Polygon A first and then perform data processing about Polygon B, it is necessary to omit data processing about the parts of (the polygon A is in a near side from Polygon B), and C. For this reason, in this example, the termination flag storage section 36 and the processing dot directions section 37 are formed.

[0052] The storage flat surface in this termination flag storage section 36 supports the dot of the display screen 1 to 1. And the data called a termination flag by 1 bitwise corresponding to each dot are memorized. Here, a termination flag means the flag used in order to indicate whether data processing of each dot was completed. For example, about the dot which data processing ended among the dots which constitute the polygon A of drawing 5 , it is "1", for

example. It is written in by the processing dot directions section 37. And in case data processing is performed about Polygon B next, the processing dot directions section 37 is always acting as the monitor of this termination flag, and this termination flag is "1". It is made not to perform data processing about a dot which has become. It becomes unnecessary to perform data processing of the polygon about the already smeared-away field after that by this, and large improvement in the speed of processing speed can be attained.
[0053] The block diagram showing the connection relation between the processing dot directions section 37 and the termination flag storage section 36 is shown in drawing 6 . As shown in this drawing, the processing dot directions section 37 is vacant with the termination flag decision section 248, and is constituted including the dot detection loop formation 282.
[0054] The termination flag decision section 248 has the function to determine the dot which needs to process in the processor section 30. The termination flag of a dot with which having processed was determined is reset up by this termination flag decision section 248 as a dot which processing newly ended, and is returned to the termination flag storage section 36. And since these directions and write return are performed every two or more dots, large improvement in the speed of processing can be attained.
[0055] by the empty dot detection loop formation 282, it should process in the termination flag decision section 248 — ** — sequential detection of the determined dot is carried out. And X* of the dot which should process based on this detection result A coordinate is determined and it is outputted to the processor section 30.
[0056] The termination flag storage section 36 is constituted so that the "termination flag" for two screens can be memorized. A termination flag is remembered that 1 bit corresponds to 1 dot by the termination flag storage section 36. For this termination flag, all for one screen are "0" to the beginning of processing of one screen. It is cleared. And it is "1" after data processing is completed. It will be set and will indicate that data processing of the dot to which its attention is paid was completed.
[0057] The termination flag storage section 36 has a two or more bits, for example, 16 bits, data bus, and access of the data for 16 bits is possible for it to coincidence. And in the operation of a dot, this termination flag storage section 36 is always referred to. Therefore, it enables this to refer to a termination flag per 16 dots. and a termination flag — "1" it is — to a dot, the dot will not be calculated but the dot concerned will be skipped by 16 dots at a high speed, i.e., max. Therefore, it is X* when the dot on the polygon which should be calculated is hidden in the inner part of other polygons. High-speed processing of being about 16 times many as this can be expected [the case where only increment a coordinate and it is calculated].
[0058] In addition, in this example, the termination flag storage section 36 has 2 screen composition. This is for performing access to the termination flag storage section 36 accompanying the operation of a dot, and the clearance for said one screen in parallel.
[0059] Moreover, in here, it is the requisite for enabling improvement in the speed of processing that processing of a polygon is performed sequentially from a front thing.
[0060] Hereafter, the configuration and actuation are explained based on the block diagram of the termination flag storage section shown in drawing 6 .
[0061] First, X* of the left profile point generated by the termination flag decision section 248 by the operation of a profile point X* of a coordinate and a right profile point A coordinate is inputted. Here, each coordinate presupposes that it consists of 10-bit data, respectively. X* of this right profile point A coordinate is right profile point X*. The register 250 for coordinates memorizes. Moreover, left profile point X* 4 bits of low order among coordinates are left profile point X*. The register 252 for coordinate low order memorizes, and 6 bits of high orders are X*. It becomes the initial value for the count of the counter 254 for coordinate high orders. And the output of this counter 254 is profile point Y*. With a coordinate and a bank-switching signal, it will be inputted into the addresses A0-A14 of the termination flag storage section 36, and the address of the termination flag storage section 36 will be specified. That is, a counter 254 will count up said address every [every 4 bits and] 16 dots. By this, from the termination flag storage section 36, data, i.e., the termination flag group corresponding to 16 dots to which its attention is paid, will be read every 16 dots, and it will be memorized through the bidirectional

buffer 262 by the register 264 for read-out.
[0062] what the mask pattern generating circuit 256 has inside a right-and-left profile point on the other hand among 16 dots to which its attention is paid — "1" ** — what carries out and is outside — "0" ** — it carries out — similarly the mask pattern in every 16 dots is generated. And the OR of said data memorized by OR circuit 258 for writing by the register 264 for read-out and this mask pattern is taken. Consequently, "an empty dot, i.e., the termination flag of a dot which it is newly going to process from now on," is "1". The updated write-in data will be generated. And after this write-in data is memorized by the register 260 for writing, it is returned to the termination flag storage section 36 through the bidirectional buffer 262. The data of 16 dots to which this pays its attention among the data of the termination flag memorized in the termination flag storage section 36 will be updated.
[0063] On the other hand, this mask pattern is reversed in an inverter circuit 266, and the data and the OR which were memorized by OR circuit 270 for read-out by the register 264 for read-out are taken. Consequently, the dot in which the outside dot and other outside polygons of a right-and-left profile point already exist is "1". It becomes and only an empty dot is "0". The becoming data will be generated. Suppose that this is temporarily called "empty dot data" here. These empty dot data are inputted into the empty dot detection loop formation 282.
[0064] In the empty dot detection loop formation 282, a multiplexer 292 incorporates said empty dot data, only when initializing the register 274 for continuous tone, and when other, it is constituted so that the data from a feedback loop may be incorporated. A self-loop formation will be formed by this. The empty dot data memorized by the register 274 for continuous tone are inputted into a priority encoder 276. This priority encoder 276 is X* most among empty dots. The value of a coordinate detects a small dot and outputs this as 4-bit data. And X* of an empty dot X* of the dot which should perform a coordinate, i.e., data processing, A coordinate is X* to the high order of this 4-bit data. It will be formed by adding 6 bit data from the coordinate high order counter 254.
[0065] The output of a priority encoder 276 is inputted into a decoder 280, and "the data with which only the dot to which its attention is paid is set to "1"" is generated in this decoder 280. An OR is taken for this data and the output of the register 274 for continuous tone by OR circuit 278, and "the data with which only the dot to which its attention is paid among empty dot data was updated by "1"" is generated. This updating data is returned to the continuous tone register 279 through a multiplexer 272. A series of actuation in this empty dot detection loop formation 282 is continued until the contents of the continuous tone register 274 become all the bits 1.
[0066] After actuation within the empty dot detection loop formation 282 is completed, the data of 16 dots as follows are read by count-up of a counter 254 from the termination flag storage section, and the above-mentioned processing is repeated.
[0067] And if it was detected and included in data of 16 dots whether the right profile point is included, from the next processing, it is X* of a new right-and-left profile point. A coordinate will be inputted and processing will be repeated.
[0068] In addition, the block diagram of the mask pattern generating circuit 256 is shown in drawing 7 . As shown in this drawing, the mask pattern generating circuit 256 is constituted including a comparator 284, OR circuits 286 and 292, the left mask pattern generating circuit 288, and the right mask pattern 290. Hereafter, actuation of this mask pattern generating circuit 256 is explained briefly.
[0069] In the left mask pattern generating circuit 288, it is left profile point X*. 4 bits of low order of a coordinate are inputted. And the left mask pattern generating circuit 288 is all the dots on the right of the dot and this which are specified among 16 dots of the beginning including a left profile point by 4 bits of this low order "1" The mask pattern to carry out is generated. Next, processing progresses, and after the first processing including a left profile point of 16 dots is completed, the contents of the register 252 are cleared. Then, the left mask pattern generating circuit 288 is all the dots that are cleared by this and process henceforth "1" The mask pattern of 16 dots to carry out is generated. As mentioned above, from the left mask pattern generating circuit 288, it is left profile point X*. It is "1" in all the dots on the right of a coordinate. The left mask pattern to carry out will be generated.

[0070] X* of the dot under processing which is the output of a counter 254 6 bits of high orders and right profile point X* of a coordinate 6 bits of high orders of a coordinate are always compared by the comparator circuit 284. And a comparator circuit 284 is the output of a counter 254, and right profile point X*. It is "1" until 6 bits of high orders of a coordinate are in agreement. It outputs, this output minds OR circuit 286, and it is "1". It becomes and is inputted into the right mask pattern generating circuit 290. [4-bit] By this, the right mask pattern generating circuit 290 will output "1" of 16 dots. When the last processing including a right profile point of 16 dots is started, the output of a comparator circuit 284 is "0". In order to change, in the right mask pattern generating circuit 290, it is right profile point X*. 4 bits of low order of a coordinate input through OR circuit 286. And the right mask pattern generating circuit 290 is all the dots on the left of the dot and this which are specified among 16 dots of the last including a right profile point by 4 bits of this low order "1" The mask pattern to carry out is generated. As mentioned above, from the right mask pattern generating circuit 290, it is right profile point X*. It is "1" in all the dots on the left of a coordinate. The right mask pattern to carry out will be generated.
[0071] The left mask pattern from these left mask pattern generating circuits 288 and the right mask pattern from the right mask pattern generating circuit 290 are inputted into AND circuit 292. Thereby, it is left profile point X*. Coordinate and right profile point X* Only the part surrounded by the coordinate is "1". The becoming mask pattern will be generated.
[0072] Next, the processing sequence chart showing actuation of the above processing dot directions section 37 and the termination flag 36 in drawing 8 explains. In addition, hereafter, in order to simplify explanation, the coordinate of a left profile point and a right profile point shall presuppose that it consists of 8 bits, and processing with a termination flag shall be performed every 4 dots. Therefore, the number of bits of each data bus in drawing 6 and drawing 7 turns into drawing 6 and the number of bits shown in the parenthesis of drawing 7 in this case. Moreover, Polygon K is already drawn and drawing 8 shows the case where Polygon L is drawn on this in piles. And since the direction of Polygon K is located toward a screen in [Polygon / L] this case in this side, the need of omitting continuous tone processing between MN(s) of drawing 8 arises.
[0073] First, left profile point X* Coordinate and right profile point X* A coordinate is inputted into registers 250 and 252 and a counter 254. In this case, left profile point X* It is (00000010) and right profile point X* as a coordinate. Suppose that 8 bit data of (00010000) were inputted as a coordinate. Then, as shown at the phase A of drawing 8 R> 8, the initial value of a counter 254 is left profile point X*. It is set as 6 bits (000000) of high orders of a coordinate. And the output of this counter 254 is inputted into the termination flag storage section 36, and the termination flag of 4 dots to which its attention is paid is read. Since Polygon K is already drawn in the example shown in drawing 8 here, in the termination flag storage section 36, between MN is "1". The becoming termination flag is memorized. However, there is no lap of a between [4 dots to which its attention is paid, and MN]. therefore, the phase A — setting (0000) — the becoming termination flag will be read and this termination flag will be memorized by the register 264 through the bidirectional buffer 262.
[0074] On the other hand, in the left mask pattern generating circuit 288 shown in drawing 7 , it is left profile point X*. 2 bits (10) of low order of a coordinate are inputted, and, thereby, 2 dots of Phase A or subsequent ones are "1". The becoming left mask pattern will be generated. Moreover, in a comparator circuit 284, they are the output (000000) of a counter 254, and right profile point X*. Since 6 bits (000100) of high orders of a coordinate are inputted, it is judged that it is inharmonious, and it is "1". It is outputted. Consequently, from the right mask pattern generating circuit 290, they are all the dots of Phase A "1" The right mask pattern to carry out is generated. As mentioned above, as shown in drawing 8 from the mask pattern generating circuit 256, 2 dot or subsequent ones is "1". The becoming mask pattern will be generated.
[0075] Next, the output (0000) of this mask pattern (0011) and a register 264 is inputted into OR circuit 258, and an OR is taken. And the result of this OR is returned to the termination flag storage section 36 through a register 260 and the bidirectional buffer 262. Thereby, the termination flag of 4 dots to which its attention is paid is rewritten from (0000) to (0011).

Consequently, about 2 dots of right-hand side in these 4 dots, the continuous tone in future data processing will be forbidden.
[0076] On the other hand, a mask pattern (0011) is reversed in an inverter circuit 266, and an OR with the output (0000) of a register 264 is taken. Data [thereby / (1100)] are memorized by the register 274 through a multiplexer 272. In here, it will be shown that the semantics of the data (1100) is a dot without the need that "dots 0 and 1" smears away, and "dots 2 and 3" is dots (empty dot) with the need of smearing away.
[0077] With the ply cage encoder 276, it is X[among empty dots] *. The smallest dot of a coordinate is detected. In this example, a dot 2, i.e., the empty dot in the 3rd dot, is detected. And based on this detection result, the data of (10) in which the 3rd dot is vacant and it is shown that it is a dot are generated. And the data of (00000010) are formed of this data of (10), and the output (000000) of a counter 254, and it is outputted to the processor section 30. Thereby, at the processor section 30, it is X*. Data processing of the dot specified with a coordinate (000010) will be performed.
[0078] On the other hand, the output (10) of a priority encoder 276 is inputted into a decoder 280. And the data (0010) with which only the dot to which its attention is paid in a decoder 280 is set to 1 are generated. next, OR circuit 278 — setting — this (0010) — the OR of the output (1100) of data and a register 274 is taken, and data (1110) are returned to a register 274.
[0079] Next, in a priority encoder 276, the 4th dot is vacant, it is detected with a dot, and data generation of (11) is carried out. And X* A coordinate (00000011) is outputted to the processor section 30. Then, the data set to a decoder 280 (0001) are generated. And the OR of this data and the output (1110) of a register 274 is taken, data (1111) are generated, and it is returned to a register 274.
[0080] At a priority encoder 276, since it is vacant from the output (1111) of a register 274 and a dot is not detected, processing of Phase A will be completed at this time.
[0081] Next, the data which a counter 254 counts up (000001) are outputted in Phase B. Thereby, a termination flag (0001) is read from the termination flag storage section 36. Moreover, since a register 252 is cleared, the data of (1111) are outputted from the mask pattern generating circuit 256. consequently, a termination flag (1111) is returned — data (0001) are both memorized by the register 274.
[0082] Next, by the empty dot detection loop formation 282, detection of an empty dot is performed until the stored data of a register 274 is set to (1111) from (0001), as shown in <u>drawing 8</u> . And X* A coordinate (00000100), (00000101), and (00000110) will be outputted to the processor section 30 one after another. If the stored data of a register 274 is set to (1111), it will shift to Phase C.
[0083] All the dots that should be processed in Phase C are dots already smeared away by Polygon K. Therefore, a termination flag is set to (1111) and processing by the empty dot detection loop formation will be performed. Thereby, large improvement in the speed of processing can be attained.
[0084] The dot which should be processed from the 14th dot starts in Phase D. Therefore, from the processing dot directions section 37, it is X*. A coordinate (00001110) and (00001111) will be outputted to the processor section 30 one by one.
[0085] In Phase E, it becomes the dot of the outside of Polygon L after 17 dot. Therefore, a right mask pattern is set to (1000) and a mask pattern is also set to (1000). Consequently, data, i.e., right profile point X, * of the 16th dot Only a coordinate (00010000) will be outputted to the processor section 30.
[0086] By this example, effective hidden surface removal which is not in the former can be performed as mentioned above by having the processing dot directions section 37 and the termination flag storage section 36. That is, according to this example, data processing is performed from the polygon which is in a near side to the display screen. Therefore, even if data processing stops meeting the deadline, the data of the polygon in a near side hardly lose. And though it draws a front in this way and being considered as preferential hardware, efficient hidden surface removal can be performed very much by making the termination flag storage section 36 memorize a termination flag at high speed. And since the data memorized by the

termination flag storage means 36 are for example, 1 bit data, there is also very little data volume of the termination flag storage means 36, and they can be carried out. Moreover, since the processing dot directions section 37 can perform decision of whether to process every two or more dots, it can be processed very much at a high speed.
[0087] Furthermore, at this example, since it is processing by introducing the concept of a mask pattern and a termination flag, hidden surface removal can be performed with a very simple configuration. When determining the dot which should process every two or more dots, what is necessary will be just to process this mask pattern and a termination flag every two or more dots by this example especially. Consequently, the image synthesizer unit concerning this example serves as configuration optimal as an image synthesizer unit which can determine the dot which should be processed every two or more dots.
[0088] In addition, this invention is not limited to the above-mentioned example, and deformation implementation various by within the limits of the summary of this invention is possible for it.
[0089] For example, although this example explained to the example the image composition which sticks a texture on a polygon by the texture-mapping technique, this invention is applicable to not only this but all kinds of the image composition technique. For example, the block diagram of the example at the time of carrying out image composition using the polygon generator 322 is shown in drawing 9 . In this example, the profile point operation part 324 and the Rhine processor 326 are built in the polygon generating circuit 322. The profile point operation part 324 asks for the image information in a right-and-left profile point from image information, such as each top-most-vertices ********** coordinate information on a polygon, and color information. And the Rhine processor 326 will smear away the dot on the scanning line which connects a right-and-left profile point using predetermined color information from the image information of this right-and-left profile point. In this Rhine processor 326, the processing for every scanning line is a high order from the processing for every polygon contrary to the previous example. Namely, between the right-and-left profile points of all the polygons on this scanning line is smeared away for every scanning line. Thus, if constituted, the termination flag storage section 36 will end by the capacity for the 1 scanning line.

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the suitable example of the image synthesizer unit concerning this invention.
[Drawing 2] It is the approximate account Fig. showing the outline of the technique of carrying out image composition of the three-dimension body with which the texture was mapped.
[Drawing 3] It is the approximate account Fig. which expressed visually the outline of the image-processing operation in this example.
[Drawing 4] It is an example of the false three-dimension image in which image composition was carried out by this example.
[Drawing 5] It is the schematic diagram showing the relation between the polygon which is in a near side toward the display screen, and the polygon in a back side.
[Drawing 6] It is the block diagram showing an example the configuration of the processing dot directions section, and connection-related [with the termination flag storage section].
[Drawing 7] It is the block diagram showing an example of the configuration of a mask pattern generating circuit.
[Drawing 8] It is an approximate account Fig. for explaining the processing sequence in the processing dot directions section and the termination flag storage section.
[Drawing 9] It is the block diagram showing the example at the time of using a polygon generating circuit as the image composition section.
[Drawing 10] It is an approximate account Fig. for explaining the concept of the image processing system which can compound a false three-dimension image.
[Drawing 11] It is the block diagram showing an example of the conventional image processing system.
[Drawing 12] It is an approximate account Fig. for explaining the continuous tone technique of the color of the conventional image processing system.
[Description of Notations]
10 Image Feed Zone
12 Control Unit
13 Game Space Operation Part
14 Central-Process Section
15 Processing Section
16 Three-Dimension Image Information Storage Section
18 Coordinate Transformation Section
19 Clipping Processing Section
20 Transparent Transformation Section
22 Sorting Processing Section
30 Processor Section
32 Main Processor
34 Co-processor
36 Termination Flag Storage Section
37 Processing Dot Directions Section

38 The Attribute RAM Section
40 Field Buffer Section
42 Texture Information Storage Section
44 Pallet & Mixer Circuit
46 CRT
248 Termination Flag Decision Section
256 Mask Pattern Generating Circuit
276 Priority Encoder
282 Empty Dot Detection Loop Formation

[Translation done.]

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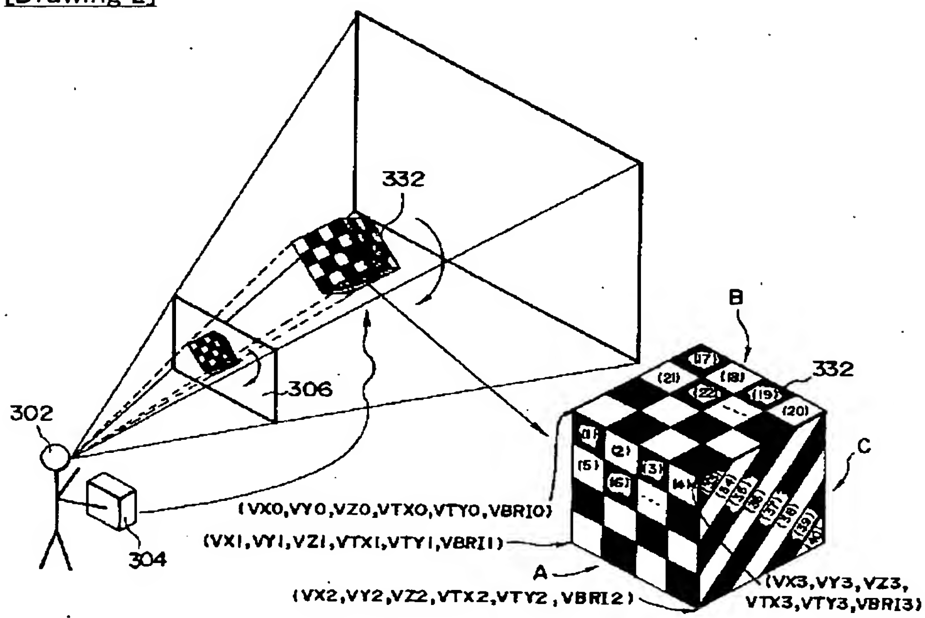
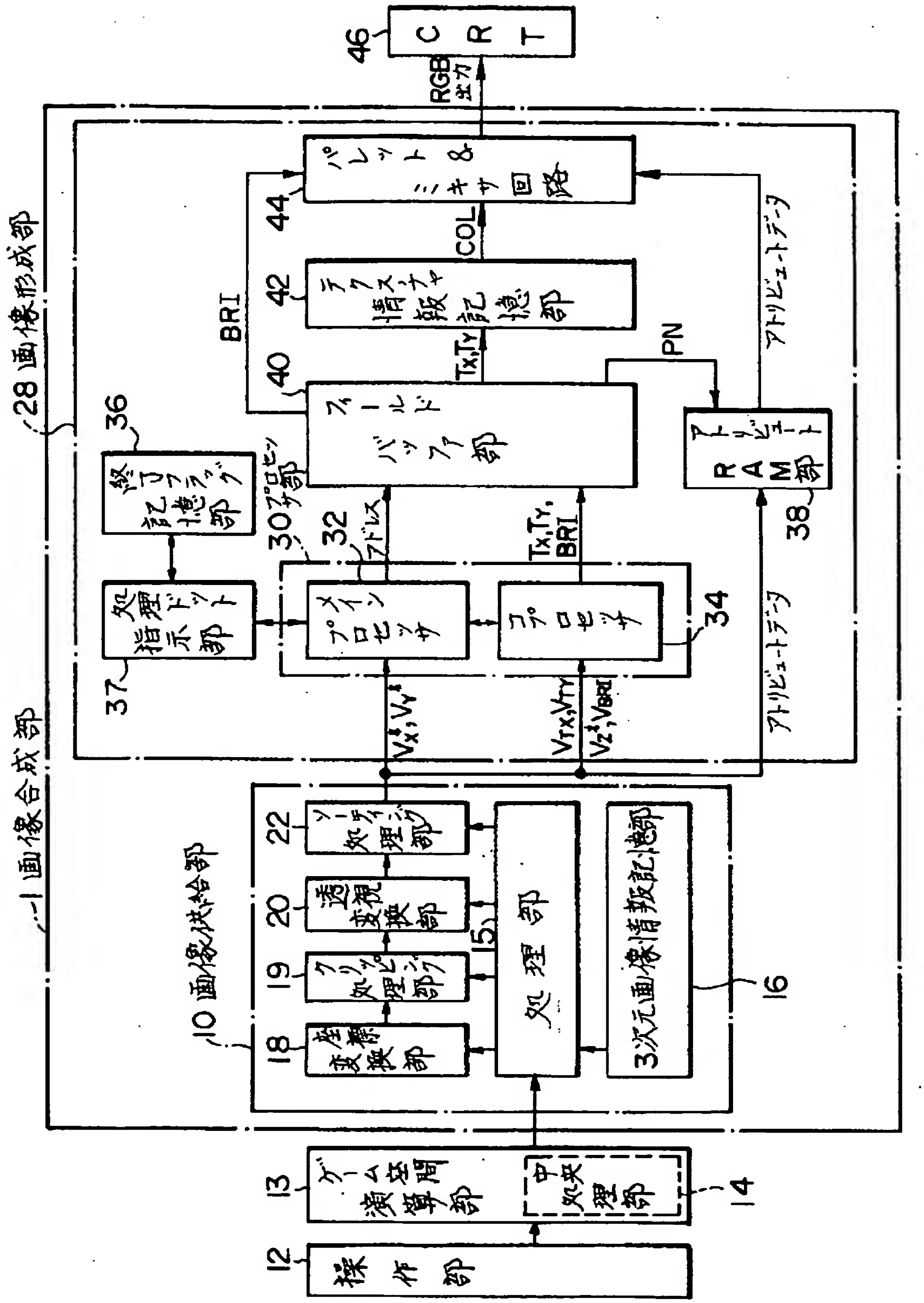
DRAWINGS

[Drawing 2]

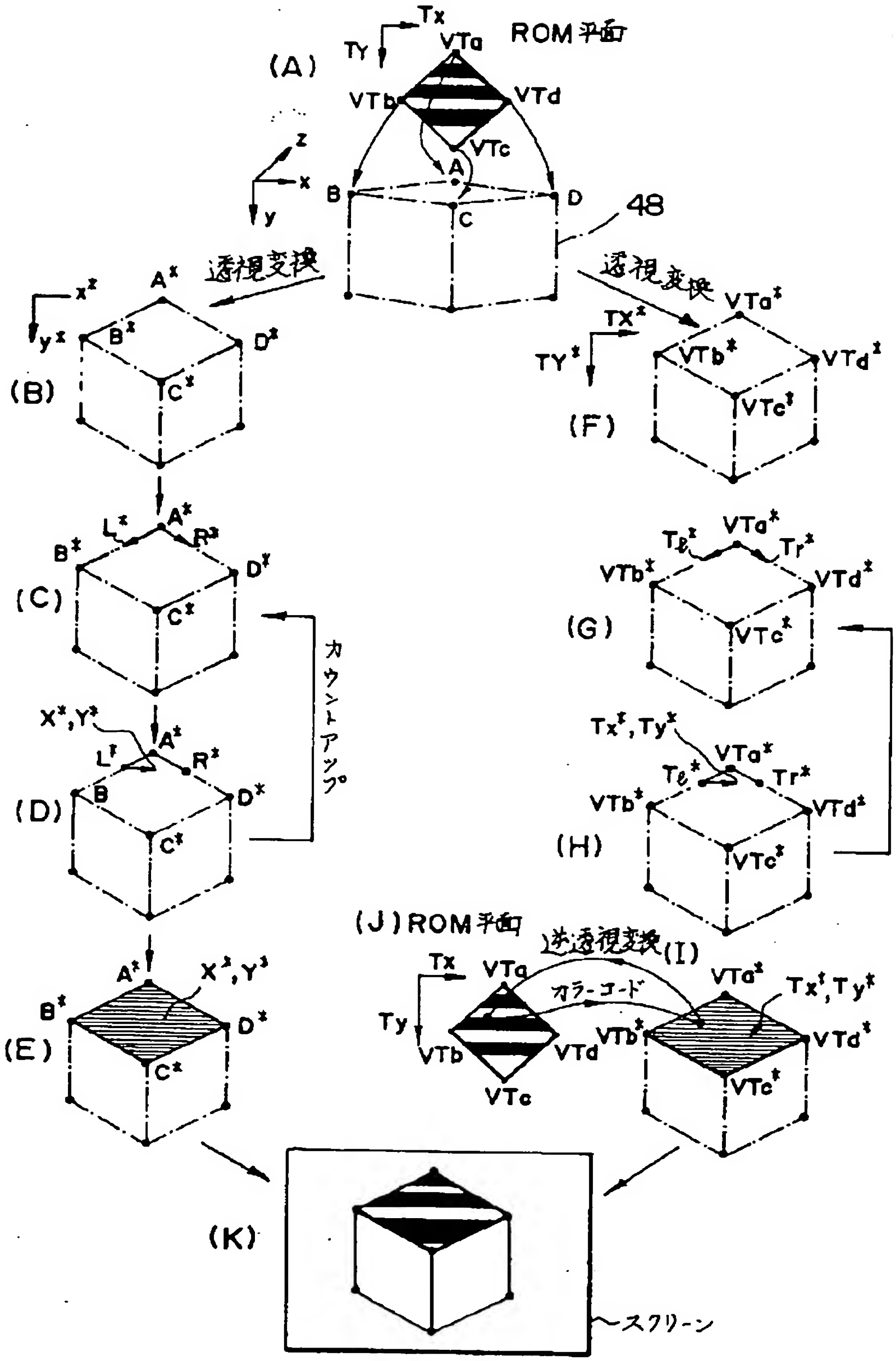


[Drawing 1]



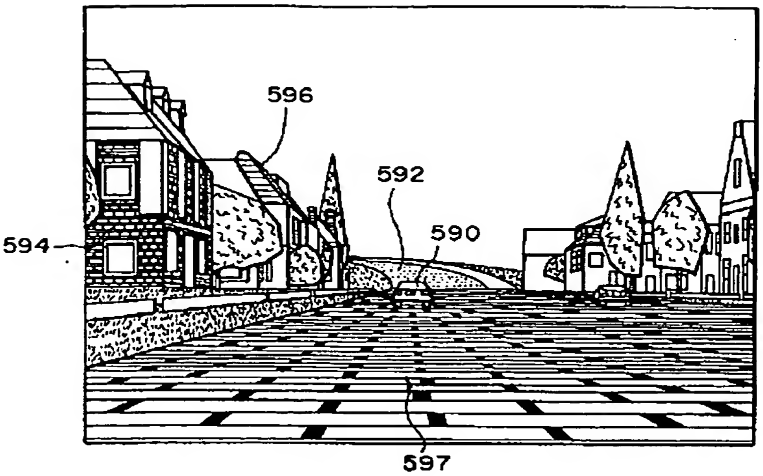
46 CRT
RGB出力
44 パレット&ミキサ回路
COL
42 テクスチャ情報記憶部
BRI
40 フィールドバッファ部
Tx,Ty
PN
38 アトリビュートRAM部
アトリビュートデータ
36 終了フラッグ記憶部
37 処理ドット指示部
30 プロセッサ部
32 メインプロセッサ
34 コプロセッサ
アドレス
Tx,Ty,BRI
Vx,Vy
VTX,VTY
VZ,VBRI
28 画像形成部
1 画像合成部
10 画像供給部
18 座標変換部
19 クリッピング処理部
20 透視変換部
22 ソーティング処理部
15 処理部
16 3次元画像情報記憶部
13 ゲーム空間演算部
14 中央処理部
12 操作部

[Drawing 3]

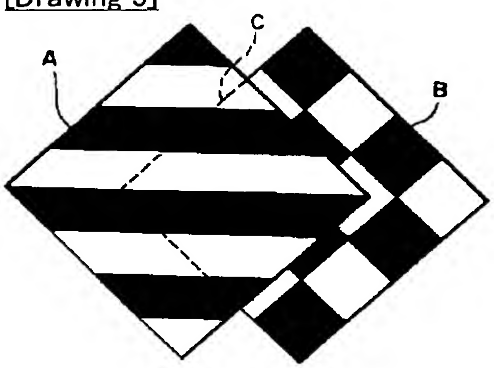


(A)
ROM平面
Tx
TY
VTa
VTb
VTd
VTc
A
B
C
D
48
z
x
y
透視変換
(B)
A*
B*
C*
D*
x*
y*
(C)
L*
R*
(D)
X*, Y*
(E)
カウントアップ
透視変換
(F)
VTa*
VTb*
VTc*
VTd*
TX*
TY*
(G)
Tℓ*
Tr*
(H)
Tx*, Ty*
(J) ROM平面
逆透視変換
(I)
カラーコード
Ty
Tx*, Ty*
(K)
スクリーン

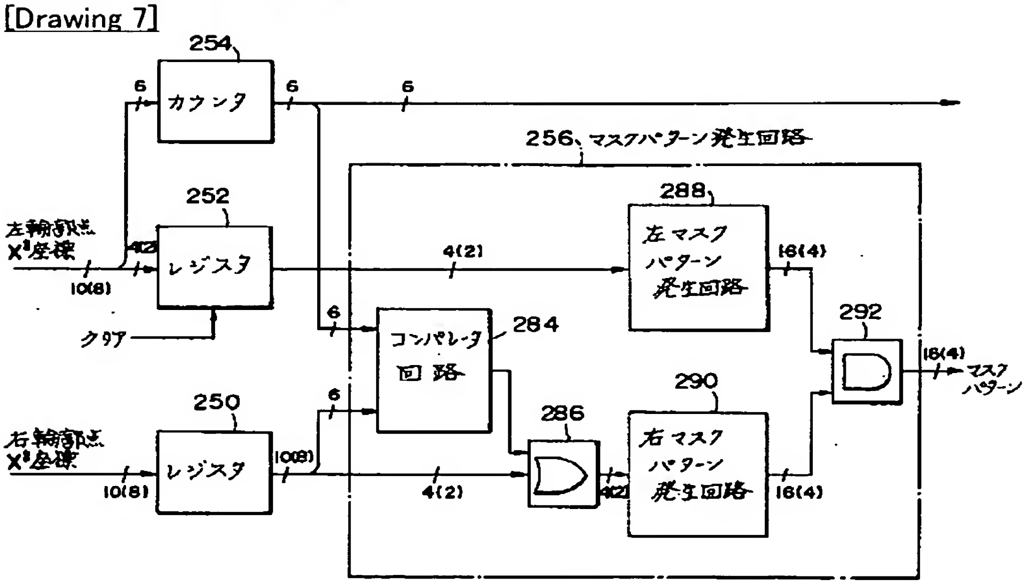
[Drawing 4]



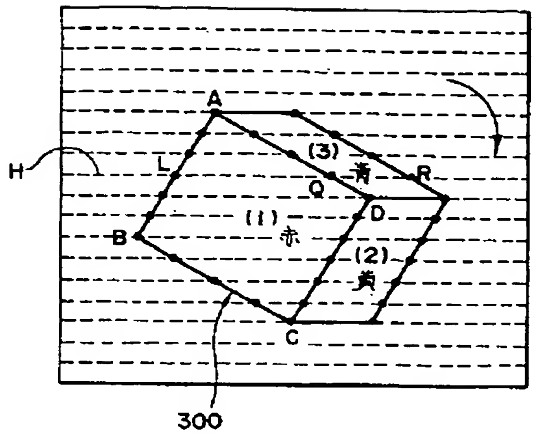
[Drawing 5]



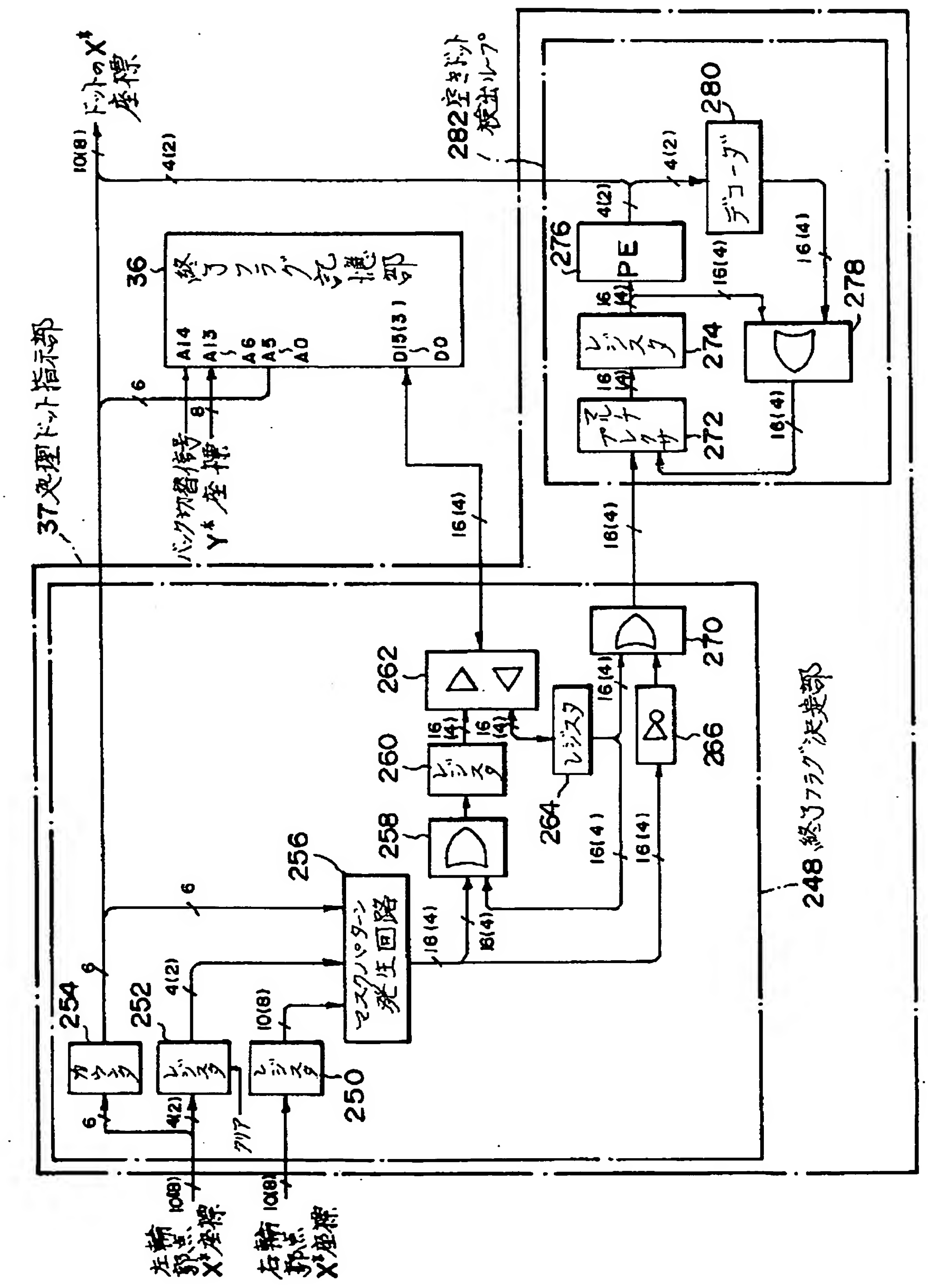
[Drawing 7]



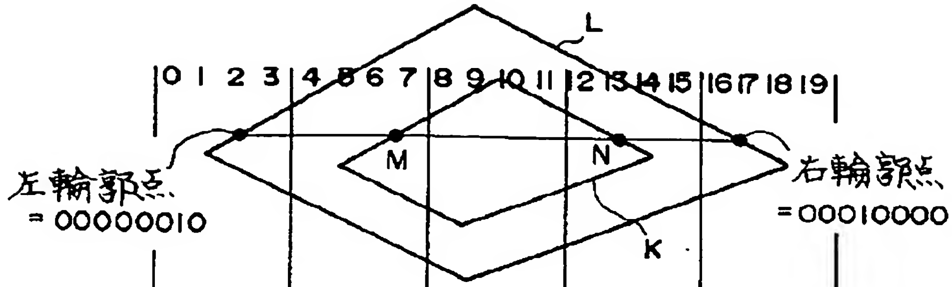
[Drawing 12]



[Drawing 6]

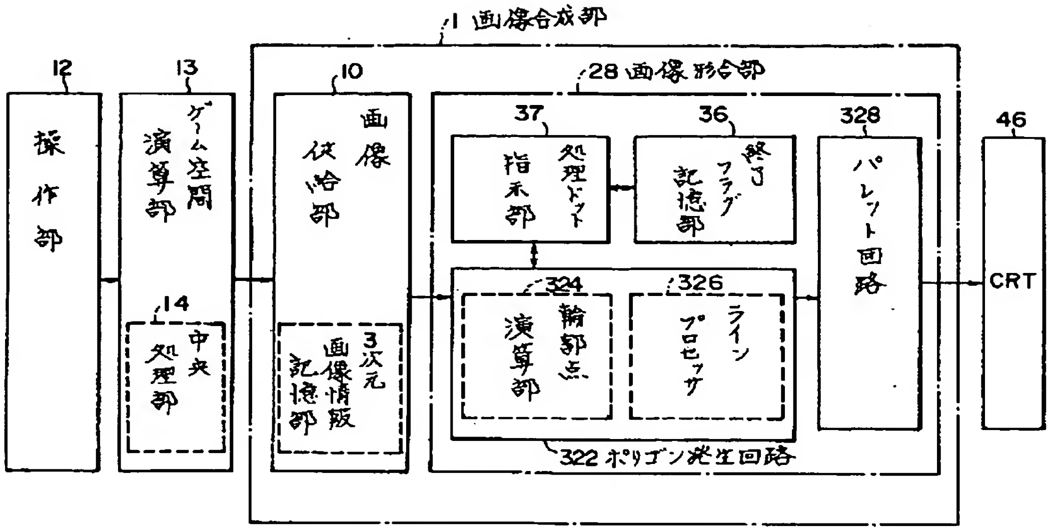

36 終了フラグ記憶部
37 処理ドット指示部
248 終了フラグ決定部
282 空きドット検出ループ
マスクパターン発生回路
レジスタ
カウンタ
クリア
デコーダ
PE
ドットのX座標
左輪郭点X座標
右輪郭点X座標
バンク切替信号
Y座標
250
252
254
256
258
260
262
264
266
270
272
274
276
278
280

[Drawing 8]

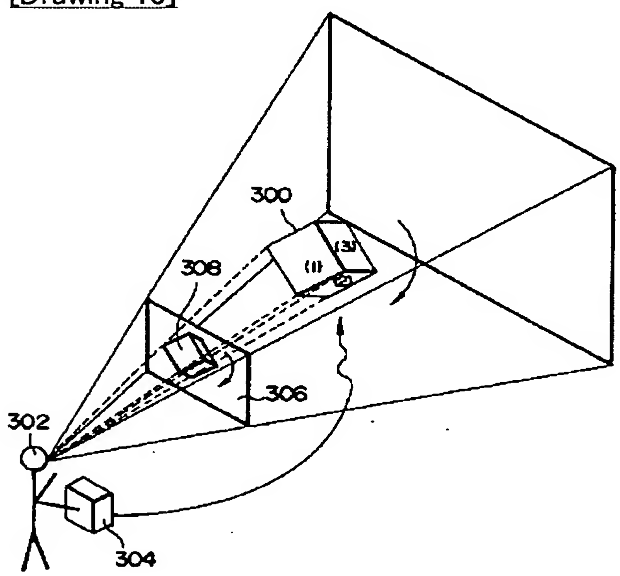


カウンタ 254	000000	000001	000010	000011	000100
終了フラグ	0 0 0 0	0 0 0 1	1 1 1 1	1 1 0 0	0 0 0 0
レジスタ 264	0 0 0 0	0 0 0 1	1 1 1 1	1 1 0 0	0 0 0 0
左 マスクパターン	0 0 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1
右 マスクパターン	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 0 0 0
マスクパターン発生回路256	0 0 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 0 0 0
書き換えられた終了フラグ	0 0 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 0 0 0
反転回路266	1 1 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 1 1 1
レジスタ 274	1 1 0 0 検出	0 0 0 1 検出	1 1 1 1	1 1 0 0 検出	0 1 1 1
PE 276	1 0	0 0	終了	1 0	0 0
X*座標出力	(000000¦10) =2	(000001¦00) = 4		(000011¦10) =14	(000100¦00) =16
デコーダ 280	0 0 1 0	1 0 0 0		0 0 1 0	1 0 0 0
レジスタ 274	1 1 1 0 検出	1 0 0 1 検出		1 1 1 0 検出	1 1 1 1
PE 276	1 1	0 1		1 1	終了
X*座標出力	(000000¦11) =3	(000001¦01) = 5		(000011¦11) =15	
デコーダ 280	0 0 0 1	0 1 0 0		0 0 0 1	
レジスタ 274	1 1 1 1	1 1 0 1 検出		1 1 1 1	
PE 276	終了	1 0		終了	
X*座標出力		(000001¦10) = 6			
デコーダ 280		0 0 1 0			
レジスタ 279		1 1 1 1 終了			
	フェイズA	フェイズB	フェイズC	フェイズD	フェイズE

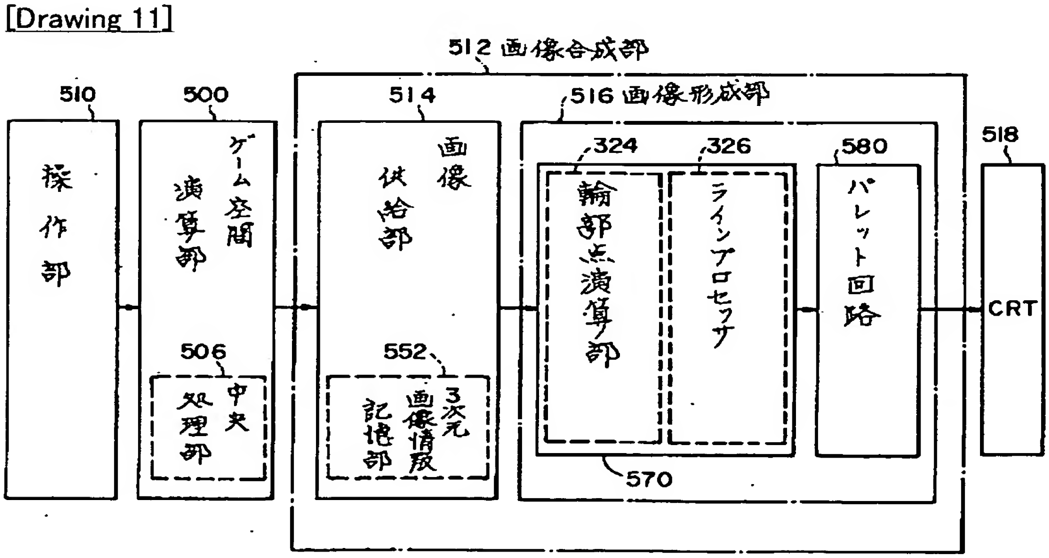
[Drawing 9]



[Drawing 10]



[Drawing 11]



[Translation done.]

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	15/66	４５０		8420－5Ｌ		
	15/70	３３０	Ｅ	9071－5Ｌ		
		３４０		9071－5Ｌ		
// Ａ６３Ｆ	9/22		Ｂ			

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(71)出願人　000134855
株式会社ナムコ
東京都大田区多摩川２丁目８番５号

(72)発明者　村田　弘幸
東京都大田区多摩川２丁目８番５号　株式会社ナムコ内

(72)発明者　横田　隆
東京都大田区多摩川２丁目８番５号　株式会社ナムコ内

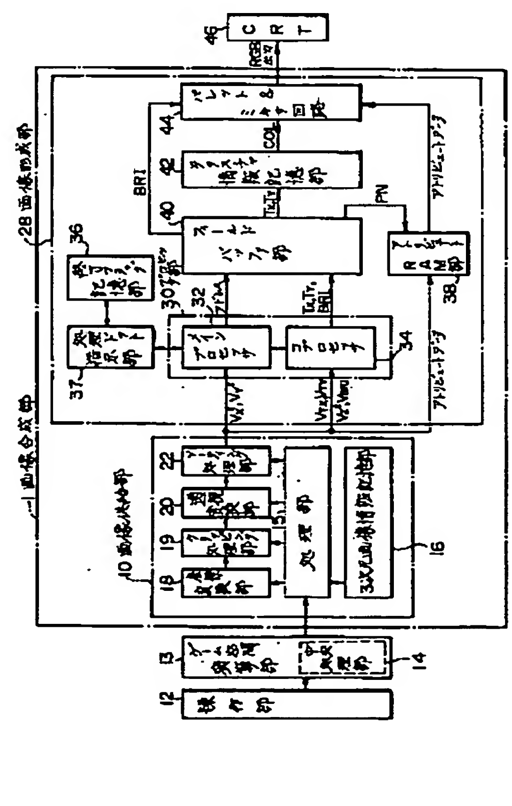
(74)代理人　弁理士　布施　行夫　（外２名）

(54)【発明の名称】　画像合成装置

(57)【要約】

【目的】　リアルタイムに高品質な画像の合成ができる画像合成装置を提供することが目的である。

【構成】　本画像合成装置では、表示画面に対して手前側にあるポリゴンから順に画像合成の演算処理が行われる。終了フラッグ記憶部３６には演算処理が終了したドットに対応するアドレス位置に終了フラッグが記憶される。そして、処理ドット指示部３７は、この終了フラッグを読み出して、処理を行うべきドットの指示をプロセッサ部３０に対して行う。この場合、処理ドット指示部３７は、処理することを決定したドットの終了フラッグを終了フラッグ記憶部３６に書き戻すとともに、処理を行うべきドットのみ演算処理を行うようプロセッサ部３０に指示する。これにより、表示画面に対して手前側にあるポリゴンから順に画像合成を行うことができるとともに、既に処理を終了した陰面部分の演算処理を省略することが可能となる。



1

【特許請求の範囲】

【請求項１】　３次元ポリゴンで構成される３次元画像を所定投影面上に透視変換して疑似３次元画像を合成する画像合成装置であって、

前記透視変換されたポリゴンの各頂点画像情報に基づいて、表示画面に対して手前に位置するポリゴンから順にポリゴンを構成する各ドットの画像情報を所定の演算処理により求める画像形成手段と、

前記画像形成手段による演算処理が終了したドットに対応するアドレス位置に、演算処理の終了を示す終了フラッグが記憶される終了フラッグ記憶手段と、

前記終了フラッグ記憶手段から前記終了フラッグを読み出し、この終了フラッグに基づいて処理を行うべきドットを前記画像形成手段に指示する処理ドット指示手段とを含み、

前記処理ドット指示手段は、処理することを決定したドットの終了フラッグを新たに処理が終了したドットとして前記終了フラッグ記憶手段に書き戻すとともに、前記画像形成手段に対して処理することを決定したドットのみ前記演算処理を行うよう指示することで処理の高速化を図ることを特徴とする画像合成装置。

【請求項２】　請求項１において、

前記終了フラッグが、複数ドット毎に前記終了フラッグ記憶手段に記憶され、

前記処理ドット指示手段が、この終了フラッグを複数ドット毎に読み出し、読み出された複数ドット毎の終了フラッグに基づいて処理を行うべきドットを決定し、前記画像形成手段に処理すべきドットの指示を行うことを特徴とする画像合成装置。

【請求項３】　請求項１又は２において、

前記画像形成手段における前記演算処理が、透視変換されたポリゴンの各頂点画像情報に基づいて、ポリゴンの輪郭線と各走査線とが交差する点である左右輪郭点を求め、この左右輪郭点を結ぶ走査線上の各ドットの画像情報を求めることにより行われ、

前記処理ドット指示手段は、前記左右輪郭点に囲まれたドットであることを指示するマスクパターンと、既に処理が終了したドットであることを指示する前記終了フラッグとを用いることにより、左右輪郭点により囲まれたドットのうち処理が終了していないドットの決定を行うことを特徴とする画像合成装置。

【請求項４】　請求項１乃至３のいずれかにおいて、

前記画像形成手段が、前記各ポリゴンの色情報と各頂点の表示座標情報に基づいて、前記ポリゴンを構成する各ドットの画像情報を所定の演算処理により求めることを特徴とする画像合成装置。

【請求項５】　請求項１乃至３のいずれかにおいて、

前記画像形成手段が、前記ポリゴンの各頂点の表示座標情報及びテクスチャ情報に基づいて、前記ポリゴンを構成する各ドットの画像情報を所定の演算処理により求めることを特徴とする画像合成装置。

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【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は画像合成装置、リアルタイムに高品質な画像合成を行うことができる画像合成装置に関する。

【０００２】

【従来の技術】従来、例えば３次元ゲームあるいは飛行機及び各種乗物の操縦シュミレ―タ等に使用される画像合成装置として種々のものが知られている。このような画像合成装置では、図１０に示す３次元物体３００に関する画像情報が、あらかじめ装置に記憶されている。そして、この画像情報をスクリーン３０６上に透視変換することにより疑似３次元画像３０８をスクリーン３０６上に画像表示している。プレーヤ３０２が、操作パネル３０４により回転、並進等の操作を行うと、装置は、この操作信号に基づいて３次元物体３００に対する回転、並進等の演算処理をリアルタイムに行う。その後、この回転等の演算処理が施された３次元画像を、スクリーン３０６上に透視変換して疑似３次元画像を表示する。この結果、プレーヤ３０２は、自身の操作により３次元物体３００をリアルタイムに回転、並進等することが可能となり、仮想的な３次元空間を疑似体験できることとなる。

【０００３】図１１には、このような画像合成装置の構成の一例が示される。なお、以下の説明では、画像合成装置を３次元ゲームに適用した場合を例にとり説明を進める。

【０００４】図１１に示すように、この画像合成装置は、操作部５１０、ゲーム空間演算部５００、画像合成部５１２、ＣＲＴ５１８により構成される。

【０００５】ゲーム空間演算部５００では、操作部５１０からの操作信号、中央処理部５０６に記憶されたゲームプログラムにしたがって、ゲーム空間の設定が行われる。即ち、３次元物体３００をどの位置に、どの方向で配置するかの演算が行われる。

【０００６】画像合成部５１２は、画像供給部５１４、画像形成部５１６を含んで構成される。そして、画像合成部５１２では、ゲーム空間演算部５００によるゲーム空間の設定情報にしたがって疑似３次元画像の画像合成が行われる。

【０００７】さて、本画像合成装置では、ゲーム空間を構成する３次元物体は、３次元のポリゴンに分割された多面体として表現されている。例えば、図１２において３次元物体３００は、３次元のポリゴン(1) ～(6) （ポリゴン(4) ～(6) は図示せず）に分割された多面体として表現される。そして、この３次元のポリゴンの各頂点の座標及び付随データ等（以下、頂点画像情報と呼ぶ）が３次元画像情報記憶部５５２に記憶されている。

【０００８】画像供給部５１４では、ゲーム空間演算部

５００の設定情報にしたがって、この頂点画像情報に対する回転、並進等の各種の演算及び透視変換等の各種の座標変換が行われる。そして、演算処理の終了した頂点画像情報は、所定の順序に並び換えられた後、画像形成部５１６に出力される。

【０００９】画像形成部５１６は、ポリゴン発生回路５７０とパレット回路５８０を含んで構成され、ポリゴン発生回路５７０は、輪郭点演算部３２４、ラインプロセッサ３２６を含んで構成される。画像形成部５１６では、ポリゴン内部の全ドットを所定の色データ等で塗りつぶす演算処理が以下の手順で行われる。

【００１０】まず、輪郭点演算部３２４において、ポリゴンの輪郭線ＡＢ、ＢＣ，ＣＤ、ＤＡ等と走査線との交点である左右輪郭点が演算される。次に、ラインプロセッサ３２６により、これらの左右輪郭点により囲まれた部分、例えば図１２におけるＬＱ間、ＱＲ間が指定された色データに塗りつぶされる。図１２においては、ＬＱ間は赤色及びＱＲ間は青色の色データに塗りつぶされる。その後、この塗りつぶされた色データはパレット回路５８０においてＲＧＢ変換され、ＣＲＴ５１８より出力表示される。

【００１１】

【発明が解決しようとする課題】ところで、このような塗りつぶし作業を行う場合に、ポリゴンとポリゴンが重なった場合は、ポリゴンのうち視点から見て手前側にある部分のみを画面に表示させる必要がある。このため、従来の画像合成装置では、表示画面に対して奥側にあるポリゴンから順次塗りつぶしてゆく手法がとられていた。

【００１２】しかし、通常、この種の画像合成装置では、リアルタイムに画像処理を行うことが要求されており、１フィールド毎、例えば１／６０秒毎に１画面分（場合によっていは２画面分）の画像データを更新してゆく必要がある。従って、当該画像合成装置には、画像処理の高速性が要求され、この高速性が担保されないと、結果的に画質を低下させてしまうこととなる。そして、この画像処理の高速性を最も律速する処理部分は、最終的に各ドットを所定の色に塗りつぶして行く処理部分である。

【００１３】ところが、従来の画像合成装置では、表示画面の奥側にあるポリゴンから順次塗りつぶして行く手法がとられていた。従って、最終的には、１フィールド内に出現する全てのポリゴンの面積分、この最も時間のかかる塗りつぶし処理を行わなければならなかった。しかし、ポリゴンとポリゴンとが重ね合って隠れた部分は、最終的には画面に表示されない部分であり、従来例はこの部分で無駄な処理を行っていたことになる。このため、従来の画像合成装置は、リアルタイムに高速に処理を行うという技術課題の達成が不十分であった。

【００１４】更に、このように表示画面の奥にあるポリゴンから色の塗りつぶしを行なわなければならないと、画面に表示すべきポリゴン数が増え、ポリゴンに対する色の塗りつぶし処理が１フィールド期間中に終了しなかった場合、手前のポリゴンのデータから喪失してしまうことになる。ところが、通常、画面の手前にあるポリゴンほどプレーヤによく見えるポリゴンであり、ゲームの構成上最も重要なポリゴンである。従って、このような重要なポリゴンのデータが喪失することは、画面の高品質性を担保する上でも好ましいものではなかった。

【００１５】本発明は、以上のような従来の課題に鑑みなされたものであり、その目的とするところは、特にリアルタイムに画像処理を行うのに最適な画像合成装置を提供することにある。

【００１６】

【課題を解決するための手段】前記目的を達成するために本発明に係る画像合成装置は、３次元ポリゴンで構成される３次元画像を所定投影面上に透視変換して疑似３次元画像を合成する画像合成装置であって、前記透視変換されたポリゴンの各頂点画像情報に基づいて、表示画面に対して手前に位置するポリゴンから順にポリゴンを構成する各ドットの画像情報を所定の演算処理により求める画像形成手段と、前記画像形成手段による演算処理が終了したドットに対応するアドレス位置に、演算処理の終了を示す終了フラッグが記憶される終了フラッグ記憶手段と、前記終了フラッグ記憶手段から前記終了フラッグを読み出し、この終了フラッグに基づいて処理を行うべきドットを前記画像形成手段に指示する処理ドット指示手段とを含み、前記処理ドット指示手段は、処理することを決定したドットの終了フラッグを新たに処理が終了したドットとして前記終了フラッグ記憶手段に書き戻すとともに、前記画像形成手段に対して処理することを決定したドットのみ前記演算処理を行うよう指示することで処理の高速化を図ることを特徴とする。

【００１７】この場合、前記終了フラッグが、複数ドット毎に前記終了フラッグ記憶手段に記憶され、前記処理ドット指示手段が、この終了フラッグを複数ドット毎に読み出し、読み出された複数ドット毎の終了フラッグに基づいて処理を行うべきドットを決定し、前記画像形成手段に処理すべきドットの指示を行うことが望ましい。

【００１８】また、この場合、前記画像形成手段における前記演算処理が、透視変換されたポリゴンの各頂点画像情報に基づいて、ポリゴンの輪郭線と各走査線とが交差する点である左右輪郭点を求め、この左右輪郭点を結ぶ走査線上の各ドットの画像情報を求めることにより行われ、前記処理ドット指示手段は、前記左右輪郭点に囲まれたドットであることを指示するマスクパターンと、既に処理が終了したドットであることを指示する前記終了フラッグとを用いることにより、左右輪郭点により囲まれたドットのうち処理が終了していないドットの決定を行うことが望ましい。

【００１９】また、前記画像形成手段は、前記各ポリゴンの色情報と各頂点の表示座標情報に基づいて、前記ポリゴンを構成する各ドットの画像情報を所定の演算処理により求めるよう構成することができる。

【００２０】更に、前記画像形成手段は、前記ポリゴンの各頂点の表示座標情報及びテクスチャ情報に基づいて、前記ポリゴンを構成する各ドットの画像情報を所定の演算処理により求める構成とすることもできる。

【００２１】

【作用】本発明によれば、画像形成手段により、表示画面に対して手前に位置するポリゴンから順に、ポリゴンを構成する各ドットの画像情報を求める演算処理が行われる。そして、既に処理が終了したドットについては、終了フラグ記憶手段に終了フラッグが記憶される。処理ドット指示手段は、終了フラッグ記憶手段からこの終了フラッグを読み出し、そのドットについて処理を行うか否かを決定する。そして、処理を行うことを決定したドットの終了フラッグを、新たに処理が終了したドットとして終了フラッグ記憶手段に書き戻す。そして、画像形成手段に対しては処理を行うと決定したドットのみ前記演算処理を行うよう指示する。このように動作することにより、本発明では、画面の手前にあるポリゴンから順に疑似３次元画像を形成して行くことができる。従って、演算処理が間に合わなくなっても、画面の手前にあるポリゴンのデータが喪失するのを有効に防止できる。更に、本発明では、手前にあるポリゴンの演算処理後、次のポリゴンの演算処理を行う場合、陰面の部分については既に終了フラッグが書き込まれている。従って、この陰面の部分については演算処理を省略でき、処理の高速化を図ることができる。

【００２２】また、本発明によれば、処理ドット指示手段は複数（Ｎ）ドット毎に終了フラッグを読み出し、処理を行うべきドットか否かを複数ドット毎に決定できる。従って、手前にあるポリゴンの陰面になっている部分については、最大でＮドット分スキップして処理を行うことができる。この結果、単に１ドットずつインクリメントして処理を行う場合に比べて、最大でＮ倍の速さで処理を行うことが可能となる。

【００２３】また、本発明によれば、左右輪郭点に囲まれたドットであるか否かはマスクパターンにより判断することができる。また、既に処理が終了したドットか否かは終了フラッグにより判断することができる。そして、処理を行うべきドットは、左右輪郭点に囲まれたドットのうち、未だ処理が終了していないドットである。従って、本発明では、このマスクパターンと終了フラッグとを用いることにより、処理を行うべきドットの決定を非常に簡易に行うことができることになる。

【００２４】また、本発明によれば、ポリゴンを用いた画像合成を簡易に行うことができ、更に、テクスチャマッピング手法を用いてリアルタイムに高品質な疑似３次元画像の合成を行うこともできる。

【００２５】

【実施例】

（１）装置全体の説明

実施例の画像合成装置は、図１に示すように、操作部１２、ゲーム空間演算部１３、画像合成部１、ＣＲＴ４６を含んで構成される。また、画像合成部１は、画像供給部１０、画像形成部２８を含んで構成される。なお、以下の説明では、本画像合成装置を３次元ゲームに適用した場合を例にとり説明する。

【００２６】ゲーム空間演算部１３では、中央処理部１４内に格納されたゲームプログラムと、操作部１２からの操作信号とによりゲーム空間の設定が行われる。具体的には、ゲーム空間を構成する３次元オブジェクト（例えば、敵飛行機、山、ビル等）の位置・方向情報、プレーヤの位置・視野方向情報等により構成されるゲーム空間設定情報が演算され、画像合成部１内の画像供給部１０へと出力される。

【００２７】画像供給部１０では、前記のゲーム空間設定情報にしたがって、所定の演算処理が行われる。具体的には、絶対座標系から視点座標系への座標変換、クリッピング処理、透視変換、ソーティング処理等の演算処理が行われ、画像形成部２８へとデータが出力される。なお、この場合、出力されるデータはポリゴン毎に分割されたデータとして表現されており、具体的にはポリゴンの各頂点の表示座標、テクスチャ座標、その他の付随情報等の頂点画像情報から構成されている。

【００２８】画像形成部２８は、このポリゴンの各頂点ごとに与えられた頂点画像情報に基づいてポリゴン内部の画像情報を演算して、これをＣＲＴ４６に出力するものである。

【００２９】さて、本実施例の画像合成装置では、より高品質の画像をより効率よく画像合成すべく、テクスチャマッピング手法及びグーローシェーディング手法と呼ぶ手法により画像合成を行っている。以下、これらの手法の概念について簡単に説明する。

【００３０】図２には、テクスチャマッピング手法の概念について示される。

【００３１】図２に示すような３次元オブジェクト３００の各面に例えば格子状、縞状の模様等が施されたものを画像合成する場合には、従来は、３次元オブジェクトを、３次元ポリゴン(1) ～(80) （３次元ポリゴン(41)～(80)については図示せず）に分割し、これらの全てのポリゴンに対して画像処理を行っていた。その理由は、従来の画像合成装置では、１つのポリゴン内の色の塗りつぶしは、指定された一つの色でしか行えなかったためである。この結果、複雑な模様等が施された高品質な画像を合成する場合には、ポリゴン数が非常に増加してしまうため、実質的に、このような高品質の画像を合成することは不可能であった。

【００３２】そこで、本画像合成装置では、３次元オブジェクト３００の回転、並進、透視変換等の座標変換及びクリッピング等の処理を、各面を構成する３次元ポリゴンＡ、Ｂ、Ｃごとに行い（具体的には各３次元ポリゴンの頂点ごと）、格子状、縞状の模様については、テクスチャとして取り扱い、ポリゴンの処理と分割して処理を行っている。即ち、図１に示すように画像形成部２８内にはテクスチャ情報記憶部４２が設けられ、この中には各３次元ポリゴンにはり付けるべきテクスチャ情報、つまり格子状、縞状の模様等の画像情報が記憶されている。

【００３３】そして、このテクスチャ情報を指定するテクスチャ情報記憶部４２のアドレスを、各３次元ポリゴンの各頂点のテクスチャ座標ＶＴＸ 、ＶＴＹ として与えておく。具体的には、図２に示すように、ポリゴンＡの各頂点に対しては、（ＶＴX0、ＶＴY0）、（ＶＴX1、ＶＴY1）、（ＶＴX2、ＶＴY2）、（ＶＴX3、ＶＴY3）のテクスチャ座標が設定される。

【００３４】画像形成部２８では、この各頂点のテクスチャ座標ＶＴＸ 、ＶＴＹ から、ポリゴン内の全てのドットについてのテクスチャ座標ＴＸ 、ＴＹ が求められる。そして、求められたテクスチャ座標ＴＸ 、ＴＹ により、テクスチャ情報記憶部２２から対応するテクスチャ情報が読み出され、図２に示すような、格子状、縞状等のテクスチャが施された３次元オブジェクトを画像合成することが可能となる。

【００３５】以上の手法によれば、データの処理量を大幅に減らすことができる。この結果、リアルタイムに高品質な画像処理を行う画像合成装置に最適な構成となる。

【００３６】また、本画像合成装置では前記したように３次元オブジェクト３００を３次元ポリゴンの固まりとして表現している。従って、各３次元ポリゴンの境界における輝度情報の連続性が問題となる。例えば複数の３次元ポリゴンを用いて球を表現しようとする場合、３次元ポリゴン内の全ドットが全て同じ輝度に設定されると、実際は「丸み」を表現したいのに、各３次元ポリゴンの境界が「丸み」として表現されない事態が生じる。そこで、本画像合成装置では、グーローシェーディングと呼ばれる手法によりこれを回避している。この手法では、前記したテクスチャマッピング手法と同様に、３次元ポリゴンの各頂点に図２に示すように各頂点の輝度情報ＶＢＲＩ０ ～ＶＢＲＩ３ を与えておき、画像形成部２８で最終的に画像表示する際に、この各頂点の輝度情報ＶＢＲＩ０ ～ＶＢＲＩ３ より３次元ポリゴン内の全てのドットについての輝度情報を補間により求めている。このようにすれば、前記した「丸み」の問題を解決できると同時に、画像合成装置内で必要とされる演算処理量を減らすことができる。従って、リアルタイムに高品質な画像処理を行う画像合成装置に最適な構成となる。

（２）画像供給部

画像供給部１０では、以下の処理が行われる。即ち、まず処理部１５は、ゲーム空間に配置すべき３次元オブジェクトの画像情報を３次元画像情報記憶部１６より読み出す。次に、処理部１５は、この３次元オブジェクトの画像情報に位置・方向情報を含ませて座標変換部１８に出力する。その後、座標変換部１８において絶対座標系から視点座標系へと座標変換が行われる。次にクリッピング処理部１９、透視変換部２０、ソーティング処理部２２において、それぞれクリッピング処理、透視変換、ソーティング処理が行われる。そして、処理が終了したポリゴンの頂点画像情報は、画像形成部２８へと出力される。

【００３７】さて、ソーティング処理部２２では、ポリゴンの頂点画像情報の出力順序を、所定の優先順位にしたがって並び換える演算処理が行われている。具体的には、ソーティング処理部２２では、表示画面に対してより手前にあるポリゴンの頂点画像情報から順に出力されることになる。従って、画像形成部２８での演算処理は、より手前にあるポリゴンから順に行われることとなる。

【００３８】このように本実施例では、表示画面に対して手前のポリゴンから順に画像形成部２８での演算処理が行われるため、従来例のように演算処理が間に合わなくなっても、手前のポリゴンのデータが喪失する可能性が非常に少なくなる。また、この場合、喪失するデータは、表示画面に対してより奥側にあるポリゴンとなるため、プレーヤの視覚に与える影響は極めて少ない。従って、より高品質な画像を生成することが可能となる。

（３）画像形成部

画像形成部２８は、ソーティング処理部２２から所定の順序にしたがって入力されたポリゴンの頂点画像情報から、３次元ポリゴン内部の全ドットの画像情報を演算する機能を有する。以下、画像形成部２８の動作の概略について説明する。

【００３９】まず、ソーティング処理部２２から、ポリゴンの頂点画像情報、即ち、ポリゴンの各頂点の表示座標、テクスチャ座標、輝度情報等がプロセッサ部３０に順次入力される。また、ポリゴン内の全てのデータに共通のデータは、アトリビュートデータとしてアトリビュートＲＡＭ部３８に入力される。

【００４０】プロセッサ部３０では、この各頂点の表示座標、テクスチャ座標、輝度情報等から、ポリゴン内の全てのドットの表示座標、テクスチャ座標ＴＸ 、ＴＹ 、輝度情報ＢＲＩが求められる。そして、この求められたテクスチャ座標ＴＸ 、ＴＹ 、輝度情報ＢＲＩは前記した表示座標をアドレスとしてフィールドバッファ部４０に書き込まれる。

【００４１】さて、メインプロセッサ３２には、処理ドット指示部３７及び終了フラグ記憶部３６が接続され

ている。この処理ドット指示部３７及び終了フラッグ記憶部３６は、既に演算処理が終了して塗りつぶしてしまったドットの演算処理を省略するために用いられるものである。これにより、その後の演算処理の負担を非常に軽減することが可能となる。なお、この処理ドット指示部３７及び終了フラッグ記憶部３６の詳細については後述する。

【００４２】画像表示する際には、このフィルードバッファ部４０からテクスチャ座標TX、TY が読み出され、これをアドレスとしてテクスチャ記憶部４２からテクスチャ情報が読み出される。そして、この情報とアトリビュートＲＡＭ部３８からのアトリビュートデータとから、パレット＆ミキサ回路４４にてＲＧＢデータが形成され、ＣＲＴ４６を介して画像出力されることになる。

【００４３】図３には、画像形成部２８において行われる演算処理の概要が視覚的に示されている。既に述べたように、画像形成部２８では、ポリゴンの頂点画像情報に基づいて、ポリゴン内の全ての画像情報を形成する演算処理が行われる。この場合、ポリゴンにはり付けるべきテクスチャ情報は、テクスチャ情報記憶部４２に記憶されており、このテクスチャ情報を読み出すために、テクスチャ座標TX 、TY が必要となる。そして、図３（F）、（G）、（H）、（I）には、ポリゴン内の全ての透視変換テクスチャ座標TX *、TY * を求める演算処理の様子が視覚的に示されている。この演算処理はコプロセッサ３４において行われる。また、図３（B）、（C）、（D）、（E）には、テクスチャ情報を表示すべき座標である透視変換表示座標X*、Y* を求める演算処理の様子が視覚的に示されている。この演算処理は、メインプロセッサ３２において行われる。そして、図３（J）に示すように、演算されれた透視変換テクスチャ座標TX *、TY * はテクスチャ座標TX 、TY に逆透視変換され、この逆透視変換されたテクスチャ座標TX 、TY により、テクスチャ情報記憶部４２からテクスチャ情報が読み出される。最後に、図３（K）に示すように、演算されたX*、Y* の座標位置に、読み出されたテクスチャ情報を対応づけることで、画像合成が行われることになる。以下に、図３（A）～（K）のそれぞれのステップで行われる演算処理の概要について説明する。

【００４４】図３（A）において、多面体４８の頂点例えばA、B、C、Dに対して、テクスチャ座標ＶTa 、ＶTb 、ＶTc 、ＶTd が対応づけられている。この頂点テクスチャ座標ＶTa ～ＶTd は、頂点A～Dにより形成されるポリゴンにはり付けるテクスチャ情報のアドレスを指定するものである。即ち、具体的にいえば、テクスチャ情報記憶部４２内の記憶手段に記憶されているテクスチャ情報を読み出すためのアドレスを指定するテクスチャ座標である。

【００４５】図３（B）、（F）において、この各頂点の表示座標A～D、テクスチャ座標ＶTa ～ＶTd は、各頂点の透視変換座標A* ～D* 、透視変換テクスチャ座標ＶTa * ～ＶTd * に透視変換される。これにより、ＸＹ座標系のみならず、Tx 、TY 座標系も透視変換されることとなり、各座標系間の線形性が保たれることとなる。

【００４６】次に、図３（C）、（G）に示すように、各頂点の透視変換座標A* ～D* 、及び、透視変換テクスチャ座標ＶTa * ～ＶTd * により形成されるポリゴンの輪郭点が線形補間演算される。即ち、図３（D）、（H）における左右輪郭点座標L* 、R* 、及び、左右輪郭点テクスチャ座標Tl * 、Tr * の線形補間演算が行われる。

【００４７】次に、図３（D）、（H）に示すように、前記左右輪郭点座標L* 、R* 、及び、左右輪郭点テクスチャ座標Tl * 、Tr * により、これらの左右輪郭点を結ぶ走査線上の各ドットの座標が線形補間演算される。

【００４８】上記した、図３（C）、（G）及び（D）、（H）の演算処理は順次繰り返され、最終的には、図３（E）、（I）に示すように、ポリゴンを構成する全てのドットの透視変換表示座標X* 、Y* 及び透視変換テクスチャ座標Tx * 、TY* の線形補間演算が行われる。

【００４９】次に、図３（J）に示すように、透視変換テクスチャ座標TX * 、TY * を、テクスチャ座標TX 、TY に逆透視変換し、このテクスチャ座標TX 、TY を用いて、前記したテクスチャ情報記憶部４２からカラーコードが読み出される。

【００５０】以上のようにして、読み出されたカラーコードを、透視変換表示座標X* 、Y* に対応させる。これにより、図３（K）に示すように、スクリーン上に画像が合成され、遠近感、直線性が損なわれないテクスチャマッピングが可能となる。

【００５１】なお、図３には、透視変換表示座標Z* 座標及び輝度情報ＢＲＩの演算方法については示されていないが、両者の演算は、図３におけるTX 、TY の演算方法とほぼ同様な演算方法により行われる。

（４）終了フラッグ記憶部、処理ドット指示部

さて、以上のようにして、それぞれのポリゴンの画像情報を演算して、これを画像合成することにより、最終的には例えば図４に示すような疑似３次元画像が形成される。この場合、図４において、遠く向こうに見える道５９２のうち、車５９０に隠れて見えない部分については画像表示する必要がない。同様に、家５９６のうち、前にある家５９４に隠れて見えない部分についても画像表示する必要がない。従って、このような部分、即ち陰面部分を除去する必要がある。この場合、本実施例の画像合成装置は、既に述べたように表示画面の手前側にある

ポリゴンから順に演算処理を行うよう形成されている。従って、図５に示すように、まずポリゴンＡについて演算処理を行い、次にポリゴンＢについて演算処理を行う場合は（ポリゴンＡの方がポリゴンＢより手前側にある）、Ｃの部分についての演算処理を省略する必要がある。このため、本実施例では、終了フラッグ記憶部３６及び処理ドット指示部３７が設けられている。

【００５２】この終了フラッグ記憶部３６内における記憶平面は、表示画面のドットに１対１に対応している。そして、各ドットに対応して例えば１ビット単位で終了フラッグと呼ばれるデータが記憶されている。ここで、終了フラッグとは、各ドットの演算処理が終了したか否かを表示するために使用されるフラッグをいう。例えば図５のポリゴンＡを構成するドットのうち演算処理が終了したドットについては、例えば”１”が処理ドット指示部３７により書き込まれる。そして、次にポリゴンＢについて演算処理を行う際には、処理ドット指示部３７は、この終了フラッグを常にモニターしており、この終了フラッグが”１”となっているドットについての演算処理を行わないようにしている。これにより、既に塗りつぶされた領域についてのポリゴンの演算処理をその後行う必要がなくなり、処理速度の大幅な高速化が図れることとなる。

【００５３】図６には、処理ドット指示部３７及び終了フラッグ記憶部３６との接続関係を示すブロック図が示される。同図に示すように、処理ドット指示部３７は、終了フラッグ決定部２４８と空きドット検出ループ２８２とを含んで構成される。

【００５４】終了フラッグ決定部２４８は、プロセッサ部３０において処理を行う必要があるドットを決定する機能を有している。処理することが決定されたドットの終了フラッグは、この終了フラッグ決定部２４８により、新たに処理が終了したドットとして設定し直され、終了フラッグ記憶部３６に書き戻される。そして、これらの指示及び書き戻しは複数ドット毎に行われるため、処理の大幅な高速化が図れることになる。

【００５５】空きドット検出ループ２８２では、終了フラッグ決定部２４８において処理を行うべきと決定されたドットが順次検出される。そして、この検出結果に基づいて、処理を行うべきドットのＸ＊座標が決定され、プロセッサ部３０に出力される。

【００５６】終了フラッグ記憶部３６は、例えば２画面分の「終了フラッグ」を記憶できるよう構成されている。終了フラッグは、１ドットに１ビットが対応するように終了フラッグ記憶部３６に記憶される。この終了フラッグは、１画面の処理の最初に、１画面分の全てが”０”にクリアされる。そして、演算処理が終了すると”１”にセットされ、着目するドットの演算処理が終了したことを表示することとなる。

【００５７】終了フラッグ記憶部３６は、複数ビット例えば１６ビットのデータバスをもち、同時に例えば１６ビット分のデータのアクセスが可能となっている。そして、ドットの演算においては、常にこの終了フラッグ記憶部３６が参照される。従って、これにより終了フラッグを１６ドット単位で参照することが可能となる。そして、終了フラッグが”１”であるドットに対しては、そのドットの演算を行わず、当該ドットは高速に、即ち最大で１６ドット分スキップされることとなる。従って、演算すべきポリゴン上のドットが、他のポリゴンの奥に隠れている場合は、Ｘ＊座標を単にインクリメントして演算する場合に比べて、例えば約１６倍の高速処理が期待できることになる。

【００５８】なお、本実施例において、終了フラッグ記憶部３６が２画面構成となっている。これは、ドットの演算に伴う終了フラッグ記憶部３６に対するアクセスと、前記１画面分のクリアとを、並行して行うためである。

【００５９】また、ここにおいて、ポリゴンの処理が手前のものから順に行われていることが、処理の高速化を可能とするための前提となっている。

【００６０】以下、図６に示す終了フラッグ記憶部のブロック図に基づき、その構成及び動作を説明する。

【００６１】まず、終了フラッグ決定部２４８に、輪郭点の演算で生成された左輪郭点のＸ＊座標及び右輪郭点のＸ＊座標が入力される。ここで、それぞれの座標はそれぞれ１０ビットのデータで構成されているとする。この右輪郭点のＸ＊座標は、右輪郭点Ｘ＊座標用のレジスタ２５０に記憶される。また、左輪郭点Ｘ＊座標のうち、下位４ビットは左輪郭点Ｘ＊座標下位用のレジスタ２５２に記憶され、上位６ビットは、Ｘ＊座標上位用のカウンタ２５４のカウントのための初期値となる。そして、このカウンタ２５４の出力は、輪郭点Ｙ＊座標及びバンク切り替え信号と共に、終了フラッグ記憶部３６のアドレスＡ０～Ａ１４に入力され、終了フラッグ記憶部３６のアドレスを指定することとなる。即ち、カウンタ２５４は、４ビット毎に、即ち１６ドット毎に前記アドレスをカウントアップすることとなる。これにより、終了フラッグ記憶部３６からは、データ即ち着目する１６ドットに対応する終了フラッグ群が１６ドット毎に読みだされ、双方向バッファ２６２を介して、読み出し用のレジスタ２６４に記憶されることとなる。

【００６２】一方、マスクパターン発生回路２５６は、着目する１６ドットの内、左右輪郭点の内側にあるものを”１”とし、外側にあるものを”０”とする同じく１６ドット毎のマスクパターンを生成している。そして、書き込み用のＯＲ回路２５８にて、読み出し用のレジスタ２６４に記憶された前記データと、このマスクパターンとの論理和がとられる。この結果、「空きドット」即ち、これから新たに処理しようとしているドットの終了フラッグが”１”に更新された書き込みデータが生成さ

れることになる。そして、この書き込みデータは、書き込み用のレジスタ２６０に記憶された後、双方向バッファ２６２を介して、終了フラッグ記憶部３６に書き戻される。これにより、終了フラッグ記憶部３６内に記憶されている終了フラッグのデータのうち、着目する１６ドットのデータが更新されることとなる。

【００６３】一方、このマスクパターンは、反転回路２６６にて反転され、読み出し用のＯＲ回路２７０にて、読み出し用のレジスタ２６４に記憶されたデータと論理和がとられる。この結果、左右輪郭点の外側のドット及び他のポリゴンがすでに存在するドットが"１"となり、空きドットのみが"０"となるデータが生成されることとなる。ここに、これを仮に「空きドットデータ」と呼ぶこととする。この空きドットデータは、空きドット検出ループ２８２に入力される。

【００６４】空きドット検出ループ２８２において、マルチプレクサ２９２は、塗りつぶし用のレジスタ２７４を初期化する時のみ前記空きドットデータを取り込み、それ以外の時は帰還ループからのデータを取り込むように構成されている。これにより自己ループが形成されることとなる。塗りつぶし用のレジスタ２７４に記憶された空きドットデータは、プライオリティエンコーダ２７６に入力される。このプライオリティエンコーダ２７６は、空きドットのうち、最もＸ* 座標の値が小さいドットを検出し、これを４ビットのデータとして出力する。そして、空きドットのＸ* 座標、即ち演算処理を行うべきドットのＸ* 座標は、この４ビットのデータの上位に、Ｘ* 座標上位カウンタ２５４からの６ビットデータを付け加えることにより形成されることとなる。

【００６５】プライオリティエンコーダ２７６の出力は、デコーダ２８０に入力され、このデコーダ２８０において、「着目するドットのみが"１"となるデータ」が生成される。このデータと、塗りつぶし用のレジスタ２７４の出力とが、ＯＲ回路２７８にて論理和がとられ、「空きドットデータのうち、着目するドットのみが"１"に更新されたデータ」が生成される。この更新データは、マルチプレクサ２７２を介して、塗りつぶしレジスタ２７９に書き戻される。この空きドット検出ループ２８２における一連の動作は、塗りつぶしレジスタ２７４の内容が全ビット１になるまで続けられる。

【００６６】空きドット検出ループ２８２内での動作が終了すると、カウンタ２５４のカウントアップにより、次の１６ドットのデータが終了フラッグ記憶部より読み出され、上記した処理が繰り返される。

【００６７】そして、１６ドットのデータの中に右輪郭点が含まれていないかどうかが検出され、含まれていたならば、次の処理からは新たな左右輪郭点のＸ* 座標が入力され、処理が繰り返されることになる。

【００６８】なお、図７には、マスクパターン発生回路２５６のブロック図が示される。同図に示すように、マスクパターン発生回路２５６は、コンパレータ２８４、ＯＲ回路２８６、２９２、左マスクパターン発生回路２８８、右マスクパターン２９０を含んで構成される。以下、このマスクパターン発生回路２５６の動作について簡単に説明する。

【００６９】左マスクパターン発生回路２８８には、左輪郭点Ｘ* 座標の下位４ビットが入力される。そして、左マスクパターン発生回路２８８は、左輪郭点を含む最初の１６ドットのうち、この下位４ビットにより指定されるドット及びこれよりも右側にあるドットを全て"１"にするマスクパターンを発生する。次に処理が進み、左輪郭点を含む最初の１６ドットの処理が終了するとレジスタ２５２の内容がクリアされる。すると、左マスクパターン発生回路２８８はこれによりクリアされ、以後に処理を行うドットを全て"１"にする１６ドットのマスクパターンを発生する。以上より、左マスクパターン発生回路２８８からは、左輪郭点Ｘ* 座標よりも右側にあるドットの全てを"１"にする左マスクパターンが発生されることになる。

【００７０】カウンタ２５４の出力である処理中のドットのＸ* 座標の上位６ビットと、右輪郭点Ｘ* 座標の上位６ビットは、コンパレータ回路２８４により常時比較されている。そして、コンパレータ回路２８４は、カウンタ２５４の出力と右輪郭点Ｘ* 座標の上位６ビットが一致するまで"１"を出力し、この出力はＯＲ回路２８６を介して４ビットの"１"となり、右マスクパターン発生回路２９０に入力される。これにより、右マスクパターン発生回路２９０は、１６ドットの"１"を出力することになる。右輪郭点を含む最後の１６ドットの処理が開始されると、コンパレータ回路２８４の出力が"０"に変わるため、右マスクパターン発生回路２９０には、右輪郭点Ｘ* 座標の下位４ビットがＯＲ回路２８６を介して入力する。そして、右マスクパターン発生回路２９０は、右輪郭点を含む最後の１６ドットのうち、この下位４ビットにより指定されるドットおよびこれよりも左側にあるドットを全て"１"にするマスクパターンを発生する。以上より、右マスクパターン発生回路２９０からは、右輪郭点Ｘ* 座標よりも左側にあるドットの全てを"１"にする右マスクパターンが発生されることになる。

【００７１】これらの左マスクパターン発生回路２８８からの左マスクパターン及び右マスクパターン発生回路２９０からの右マスクパターンは、ＡＮＤ回路２９２に入力されている。これにより、左輪郭点Ｘ* 座標と右輪郭点Ｘ* 座標に囲まれた部分のみ"１"になるマスクパターンが発生されることになる。

【００７２】次に、以上の処理ドット指示部３７及び終了フラッグ３６の動作を図８に示す処理順序表により説明する。なお、以下、説明を簡単にするために、左輪郭点、右輪郭点の座標は８ビットで構成されているとし、

終了フラッグによる処理は４ドット毎に行われるものとする。従って、この場合は、図６、図７におけるそれぞれのデータバスのビット数は、図６、図７のカッコ内に示すビット数になる。また、図８は、既にポリゴンＫが描かれており、これにポリゴンＬを重ねて描く場合について示している。そして、この場合、ポリゴンＫの方がポリゴンＬよりも画面に向かって手前にあるので、図８のＭＮ間において塗りつぶし処理を省略する必要が生ずる。

【００７３】まず、左輪郭点Ｘ＊座標、右輪郭点Ｘ＊座標がレジスタ２５０、２５２、カウンタ２５４に入力される。この場合、左輪郭点Ｘ＊座標として（０００００００１０）、右輪郭点Ｘ＊座標として（０００１００００）の８ビットデータを入力されたとする。すると、図８のフェイズＡに示すように、カウンタ２５４の初期値は、左輪郭点Ｘ＊座標の上位６ビット（０００００００）に設定される。そして、このカウンタ２５４の出力は終了フラッグ記憶部３６に入力され、着目する４ドットの終了フラッグが読み出される。ここで図８に示す例ではポリゴンＫが既に描かれているため、終了フラッグ記憶部３６には、ＭＮ間のみ”１”となる終了フラッグが記憶されている。しかし、着目する４ドットとＭＮ間との重なりはない。従って、フェイズＡにおいては（００００）となる終了フラッグが読み出され、この終了フラッグが双方向バッファ２６２を介してレジスタ２６４に記憶されることになる。

【００７４】一方、図７に示す左マスクパターン発生回路２８８には、左輪郭点Ｘ＊座標の下位２ビット（１０）が入力され、これにより、フェイズＡの２ドット以降が”１”となる左マスクパターンを発生することになる。また、コンパレータ回路２８４では、カウンタ２５４の出力（００００００）及び右輪郭点Ｘ＊座標の上位６ビット（０００１００）が入力されるため、不一致と判断され”１”が出力される。この結果、右マスクパターン発生回路２９０からは、フェイズＡの全てのドットを”１”とする右マスクパターンが発生する。以上より、マスクパターン発生回路２５６からは、図８に示すように２ドット以降が”１”となるマスクパターンが発生することになる。

【００７５】次に、このマスクパターン（００１１）とレジスタ２６４の出力（００００）がＯＲ回路２５８に入力され論理和がとられる。そして、この論理和の結果は、レジスタ２６０、双方向バッファ２６２を介して終了フラッグ記憶部３６に書き戻される。これにより、着目する４ドットの終了フラッグは（００００）から（００１１）に書き換えられる。この結果、この４ドット中の右側２ドットについては、以後の演算処理における塗りつぶしが禁止されることになる。

【００７６】一方、マスクパターン（００１１）は反転回路２６６にて反転され、レジスタ２６４の出力（００００）との論理和がとられる。これにより（１１００）のデータがマルチプレクサ２７２を介してレジスタ２７４に記憶される。ここにおいて、（１１００）というデータの意味は、「ドット０、１」は塗りつぶす必要のないドットであり、「ドット２、３」は塗りつぶす必要のあるドット（空きドット）であることを示すことになる。

【００７７】プライオリエンコーダ２７６では、空きドットのうちＸ＊座標の最も小さいドットが検出される。この例では、ドット２、即ち３ドット目にある空きドットが検出される。そして、この検出結果に基づいて、３ドット目が空きドットであることを示す（１０）のデータが生成される。そして、この（１０）のデータと、カウンタ２５４の出力（００００００）とにより（００００００１０）のデータが形成され、プロセッサ部３０に出力される。これにより、プロセッサ部３０ではＸ＊座標（００００１０）で指定されるドットの演算処理を行うことになる。

【００７８】一方、プライオリティエンコーダ２７６の出力（１０）は、デコーダ２８０に入力される。そして、デコーダ２８０において着目するドットのみ１となるデータ（００１０）が生成される。次に、論理和回路２７８において、この（００１０）のデータとレジスタ２７４の出力（１１００）の論理和がとられ、データ（１１１０）がレジスタ２７４に書き戻される。

【００７９】次に、プライオリティエンコーダ２７６では、４ドット目が空きドットと検出され（１１）のデータ生成される。そしてＸ＊座標（０００００１１）がプロセッサ部３０に出力される。その後、デコーダ２８０において（０００１）のデータが生成される。そして、このデータとレジスタ２７４の出力（１１１０）との論理和がとられデータ（１１１１）が生成され、レジスタ２７４に書き戻される。

【００８０】プライオリティエンコーダ２７６では、レジスタ２７４の出力（１１１１）から空きドットが検出されないため、この時点でフェイズＡの処理が終了することになる。

【００８１】次にフェイズＢにおいて、カウンタ２５４がカウントアップし（００００１）のデータが出力される。これにより終了フラッグ（０００１）が、終了フラッグ記憶部３６より読み出される。また、レジスタ２５２がクリアされるためマスクパターン発生回路２５６からは（１１１１）のデータが出力される。この結果、終了フラッグ（１１１１）が書き戻されるともに、レジスタ２７４にデータ（０００１）が記憶される。

【００８２】次に、空きドット検出ループ２８２では、図８に示すように、レジスタ２７４の記憶データが（０００１）から（１１１１）になるまで、空きドットの検出が行われる。そして、Ｘ＊座標（００００００１００）、（０００００１０１）、（０００００１１０）が

次々に、プロセッサ部３０に出力されることになる。レジスタ２７４の記憶データが（１１１１）になるとフェイズCに移行する。

【００８３】フェイズCにおいて処理すべきドットは、全て既にポリゴンKにより塗りつぶされているドットである。従って、終了フラッグは（１１１１）となり、空きドット検出ループでの処理は行われないことになる。これにより処理の大幅な高速化を図ることができる。

【００８４】フェイズDにおいては、１４ドット目から処理すべきドットが始まる。従って、処理ドット指示部３７からは、X* 座標（００００１１１０）、（００００１１１１）が順次プロセッサ部３０に出力されることになる。

【００８５】フェイズEにおいては、１７ドット以降はポリゴンLの外側のドットになる。従って、右マスクパターンが（１０００）となり、マスクパターンも（１０００）となる。この結果、１６ドット目のデータ、即ち右輪郭点X* 座標（０００１００００）のみが、プロセッサ部３０に出力されることになる。

【００８６】以上のように本実施例では、処理ドット指示部３７及び終了フラッグ記憶部３６とを備えることにより、従来にない効果的な陰面消去を行うことができる。即ち、本実施例によれば表示画面に対して手前側にあるポリゴンから演算処理が行われる。従って、演算処理が間に合わなくなっても、手前側にあるポリゴンのデータが喪失することがほとんどない。そして、このように前描き優先のハードウェアとしながらも、終了フラッグを終了フラッグ記憶部３６に記憶させることで、非常に高速で、効率のよい陰面消去を行うことができる。そして、終了フラッグ記憶手段３６に記憶されるデータは例えば１ビットデータであるため、終了フラッグ記憶手段３６のデータ容量も非常に少なくすることができる。また、処理ドット指示部３７は、複数ドット毎に処理を行うべきか否かの決定をできるため、非常に高速に処理を行うことができる。

【００８７】更に、本実施例では、マスクパターンと終了フラッグという概念を導入して処理を行っているため、非常に簡易な構成で陰面消去を行うことができる。特に、本実施例では、複数ドット毎に処理を行うべきドットを決定する場合には、このマスクパターンと終了フラッグとを複数ドット毎に処理すればよいことになる。この結果、本実施例に係る画像合成装置は、複数ドット毎に処理すべきドットを決定できる画像合成装置として最適な構成となる。

【００８８】なお、本発明は上記実施例に限定されるものではなく、本発明の要旨の範囲内で種々の変形実施が可能である。

【００８９】例えば本実施例では、テクスチャマッピング手法によりポリゴンにテクスチャをはり付ける画像合成を例に説明したが、本発明はこれに限らずあらゆる種類の画像合成手法に適用できる。例えば、図９には、ポリゴン発生器３２２を用いて画像合成した場合の実施例のブロック図が示される。この実施例では、ポリゴン発生回路３２２に輪郭点演算部３２４及びラインプロセッサ３２６が内蔵されている。輪郭点演算部３２４は、ポリゴンの各頂点与えられた座標情報、色情報等の画像情報から左右輪郭点における画像情報を求める。そして、ラインプロセッサ３２６は、この左右輪郭点の画像情報より、左右輪郭点を結ぶ走査線上のドットを所定の色情報により塗りつぶすことになる。このラインプロセッサ３２６においては、先の実施例とは逆に走査線ごとの処理がポリゴンごとの処理より上位になっている。即ち、１走査線ごとに、この走査線上にある全てのポリゴンの左右輪郭点間を塗りつぶす。このように構成すると、終了フラッグ記憶部３６が１走査線分の容量ですむ。

【００９０】

【発明の効果】本発明によれば、画面の手前にあるポリゴンから順に疑似３次元画像を形成して行くことができるとともに、手前にあるポリゴンの演算処理後、次のポリゴンの演算処理を行う場合、陰面の部分については既に終了フラッグが書き込まれているため、この陰面の部分については演算処理を省略できる。従って、演算処理が間に合わなくなっても、画面の手前にあるポリゴンのデータが喪失するのを有効に防止できるとともに、処理の大幅な高速化を図ることができる。特に、本発明は、データ量の少ない終了フラッグを用いて陰面か否かの判断を行っているため、処理を高速に出来るともに、記憶手段の記憶容量を節約することもできる。

【００９１】また、本発明によれば、手前にあるポリゴンの陰面になっている部分については、最大でNドット分スキップして処理を行うことができる。この結果、単に１ドットずつインクリメントして処理を行う場合に比べて、最大でN倍の速さで処理を行うことが可能となる。

【００９２】また、本発明によれば、マスクパターンと終了フラッグとを用いることにより、処理を行うべきドットの決定を非常に簡易に行うことができる。特に、本発明によれば、複数ドット毎に処理を行うべきドットを決定する場合には、マスクパターン及び終了フラグを複数ドット毎に処理すればよいことになる。この結果、マスクパターン及び終了フラッグを用いた本発明は、複数ドット毎に処理すべきドットを決定できる画像合成装置として、最適な構成となる。

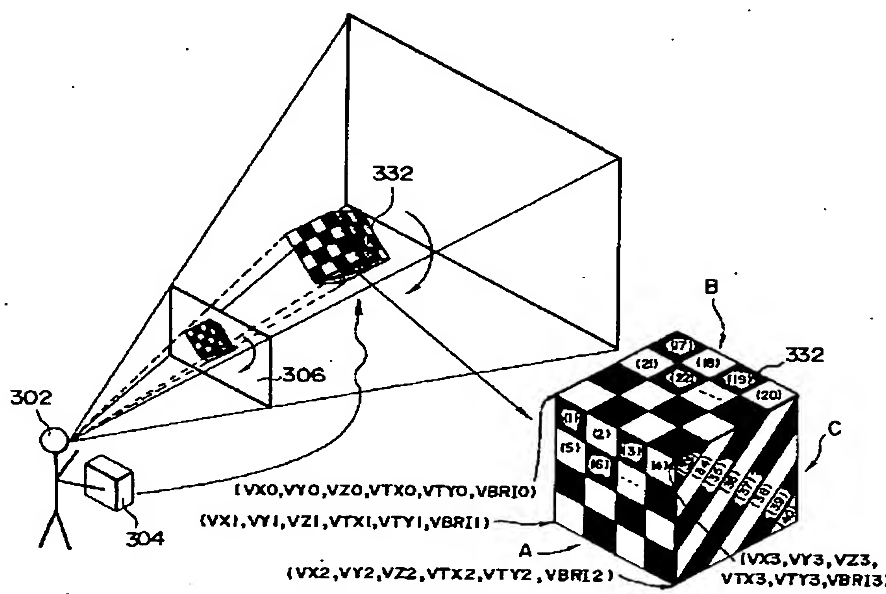
【００９３】また、本発明によれば、ポリゴンあるいはテクスチャマッピング手法を用いて高品質でリアルタイムな疑似３次元画像の合成を、より簡易な構成で行うことができる。

【図面の簡単な説明】

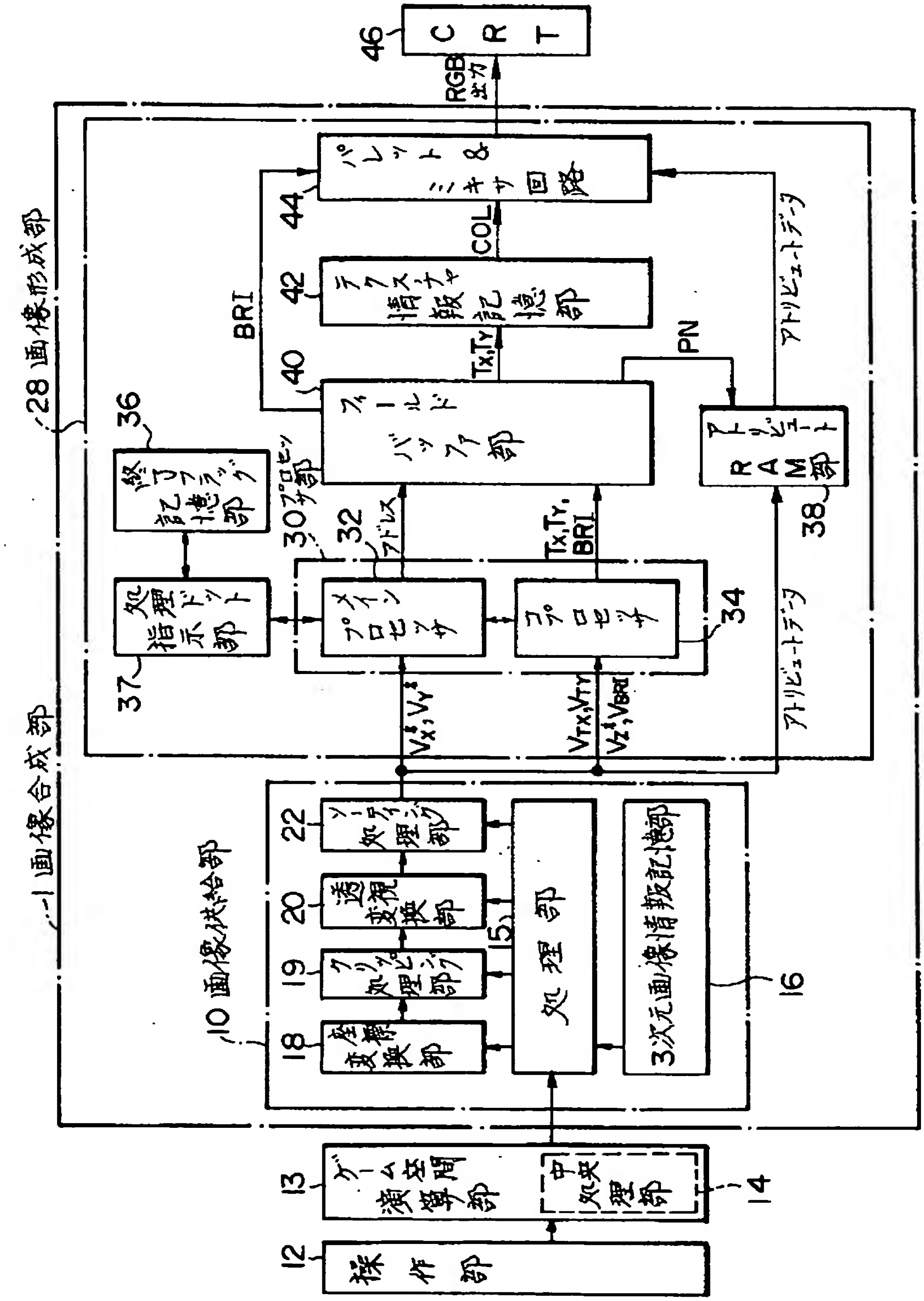
【図１】本発明にかかる画像合成装置の好適な実施例について示すブロック図である。

【図２】テクスチャがマッピングされた３次元物体を画像合成する手法の概要を示す概略説明図である。
【図３】本実施例における画像処理演算の概要を視覚的に表した概略説明図である。
【図４】本実施例により画像合成された疑似３次元画像の一例である。
【図５】表示画面に向かって手前側にあるポリゴンと奥側にあるポリゴンの関係を示す概略図である。
【図６】処理ドット指示部の構成及び終了フラッグ記憶部との接続関係の一例について示すブロック図である。
【図７】マスクパターン発生回路の構成の一例について示すブロック図である。
【図８】処理ドット指示部及び終了フラッグ記憶部における処理順序を説明するための概略説明図である。
【図９】画像合成部としてポリゴン発生回路を用いた場合の例を示すブロック図である。
【図１０】疑似３次元画像を合成できる画像処理装置の概念について説明するための概略説明図である。
【図１１】従来の画像処理装置の一例を示すブロック図である。
【図１２】従来の画像処理装置の色の塗りつぶし手法を説明するための概略説明図である。
【符号の説明】
１０　画像供給部
１２　操作部
１３　ゲーム空間演算部
１４　中央処理部
１５　処理部
１６　３次元画像情報記憶部
１８　座標変換部
１９　クリッピング処理部
２０　透視変換部
２２　ソーティング処理部
３０　プロセッサ部
３２　メインプロセッサ
３４　コプロセッサ
３６　終了フラッグ記憶部
３７　処理ドット指示部
３８　アトリビュートＲＡＭ部
４０　フィールドバッファ部
４２　テクスチャ情報記憶部
４４　パレット＆ミキサ回路
４６　ＣＲＴ
２４８　終了フラッグ決定部
２５６　マスクパターン発生回路
２７６　プライオリティエンコーダ
２８２　空きドット検出ループ

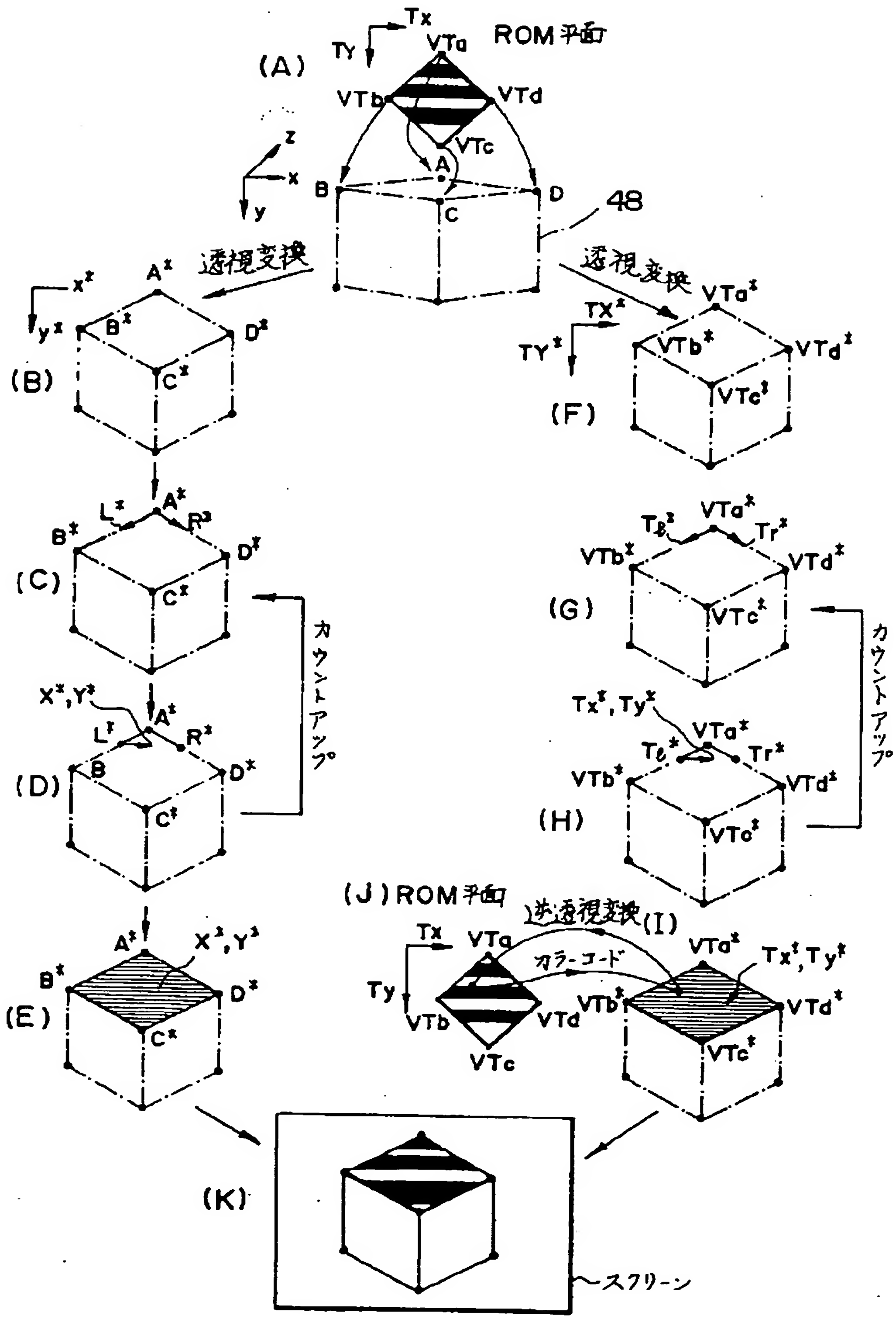
【図２】



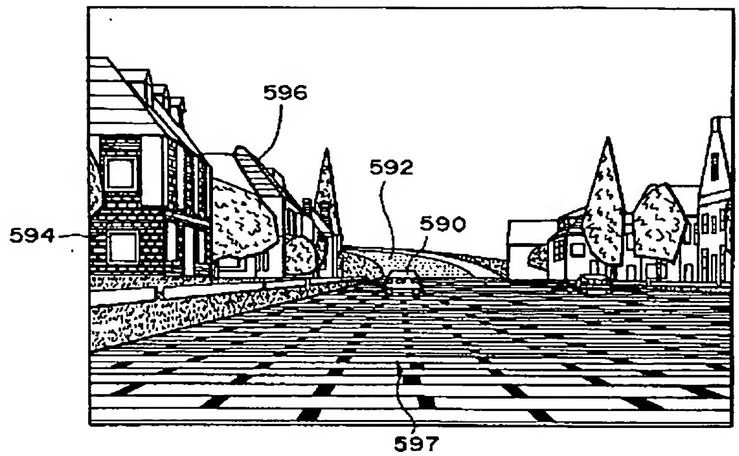
【図1】


46
CRT
RGB出力
44
パレット&ミキサ回路
COL
42
テクスチャ情報記憶部
BRI
Tx,Ty
40
フィールドバッファ部
PN
アトリビュートデータ
アトリビュートRAM部
38
36
終了フラッグ記憶部
30 プロセッサ部
32
アドレス
Tx,Ty,BRI
処理ドット指示部
37
メインプロセッサ
コプロセッサ
34
Vx*,Vy*
VTX,VTY
Vz*,VBRI
アトリビュートデータ
28 画像形成部
1 画像合成部
10 画像供給部
22
ソーティング処理部
20
透視変換部
19
クリッピング処理部
18
座標変換部
15
処理部
3次元画像情報記憶部
16
13
ゲーム空間演算部
中央処理部
14
12
操作部

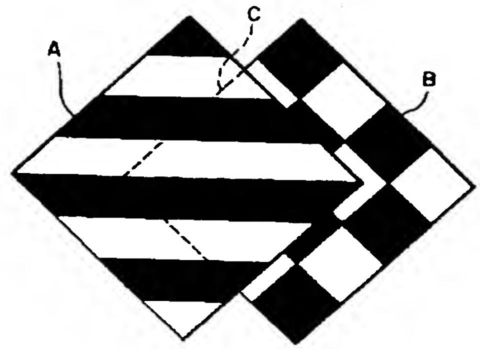
【図３】


(A)
ROM平面
Tx
TY
VTa
VTb
VTd
VTc
z
x
y
A
B
C
D
48
透視変換
透視変換
(B)
(C)
(D)
(E)
(F)
(G)
(H)
(I)
(J) ROM平面
(K)
カウントアップ
カウントアップ
逆透視変換
カラーコード
スクリーン

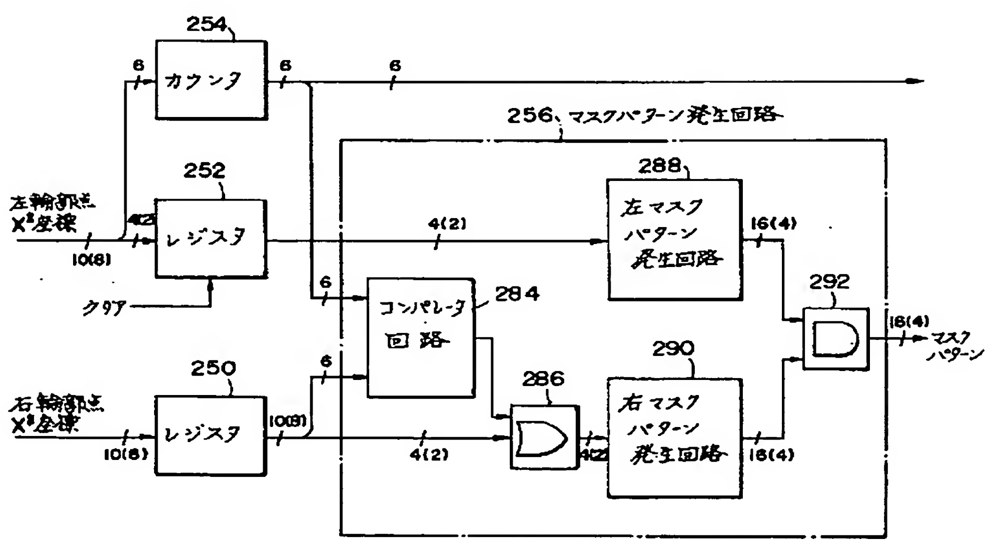
【図4】


596
592
590
594
597

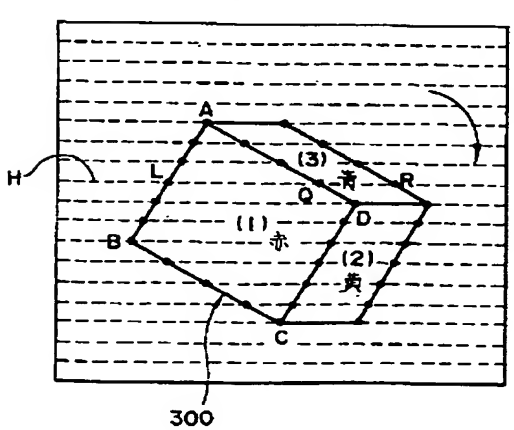
【図5】


A
B
C

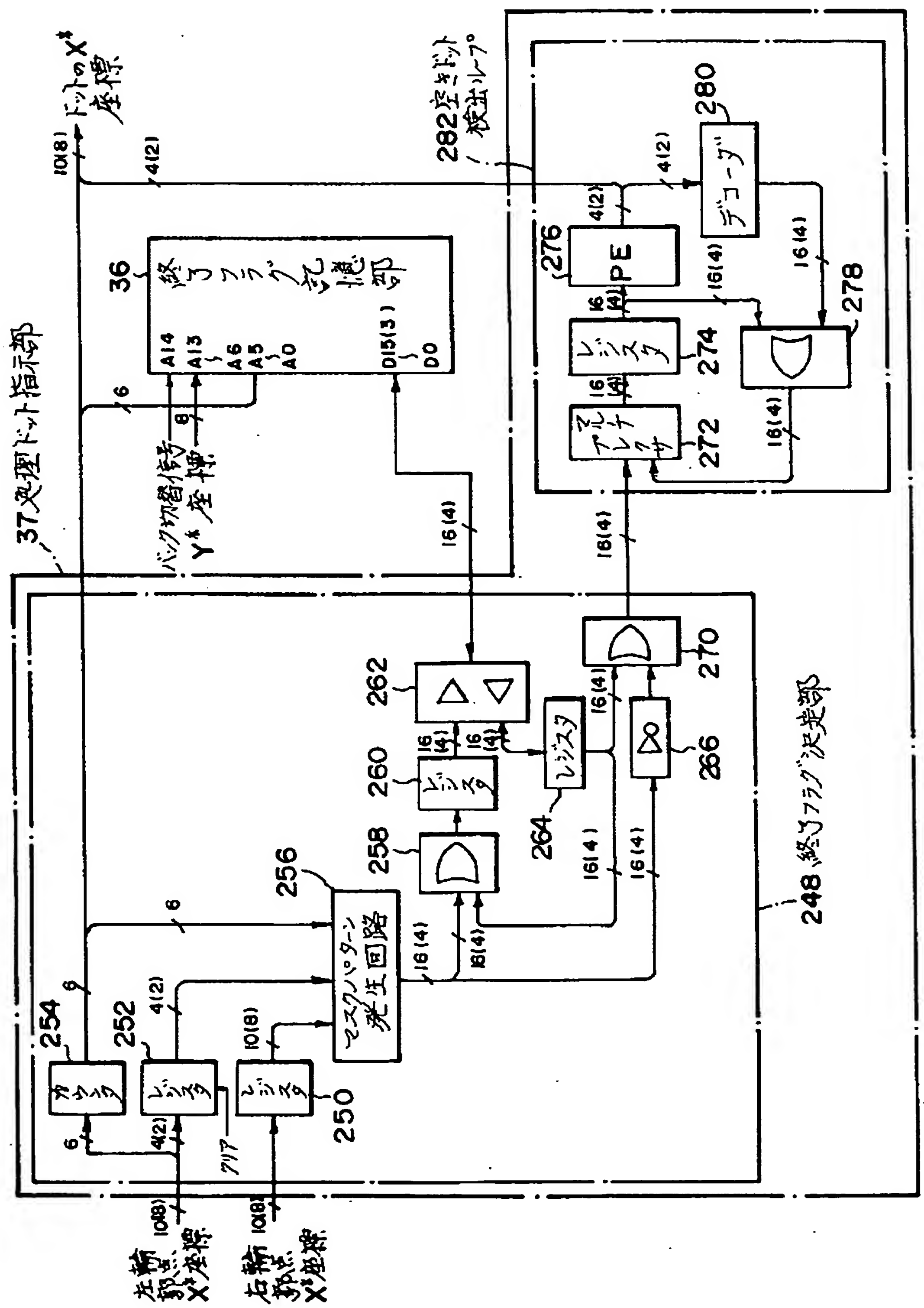
【図7】


254
カウンタ
256 マスクパターン発生回路
252
288
左マスクパターン発生回路
左輪郭点X座標
レジスタ
クリア
284
コンパレータ回路
292
250
286
290
右マスクパターン発生回路
右輪郭点X座標
レジスタ
マスクパターン

【図12】

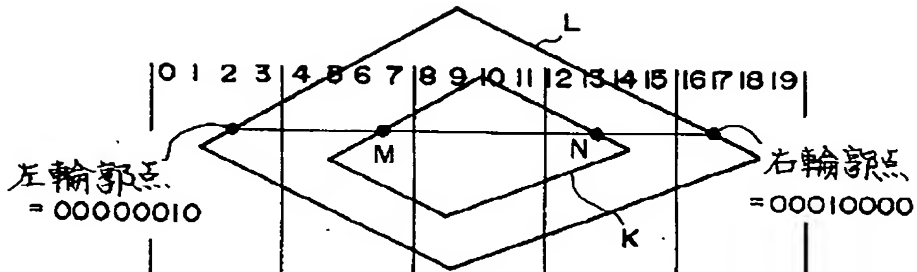

A
L
(3)
青
R
Q
D
H
B
(1)
赤
(2)
黄
C
300

【図６】



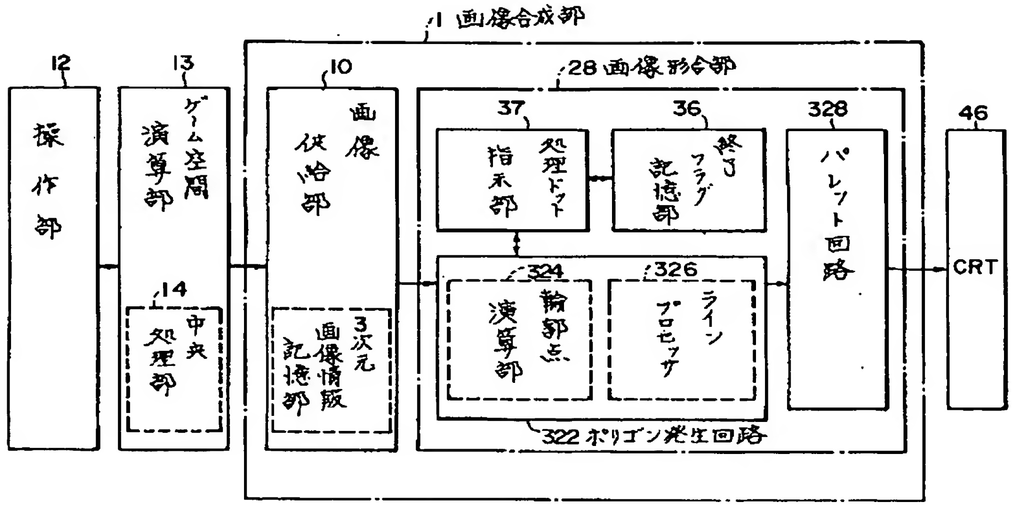
37 処理ドット指示部
36 終了フラグ記憶部
248 終了フラグ決定部
282 空きドット検出ループ
ドットのX座標
バンク切替信号
Y座標
左輪郭点X座標
右輪郭点X座標
カウンタ
レジスタ
クリア
マスクパターン発生回路
マルチプレクサ
PE
デコーダ

【図8】

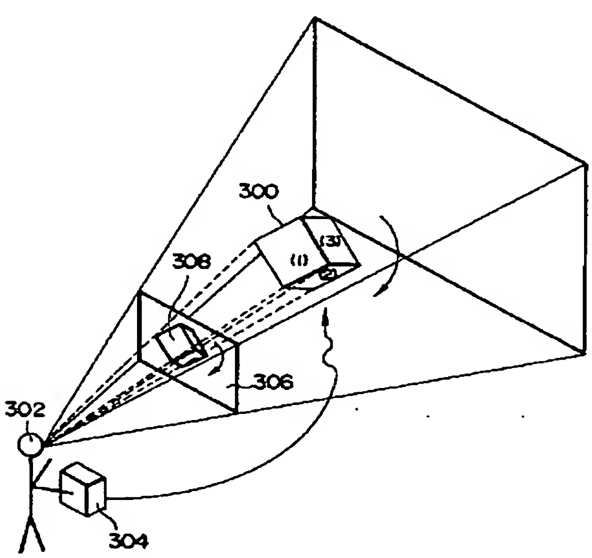


	フェイズA	フェイズB	フェイズC	フェイズD	フェイズE
カウンタ 254	000000	000001	000010	000011	000100
終了フラグ	0000	0001	1111	1100	0000
レジスタ 264	0000	0001	1111	1100	0000
左マスクパターン	0011	1111	1111	1111	1111
右マスクパターン	1111	1111	1111	1111	1000
マスクパターン発生回路256	0011	1111	1111	1111	1000
書き換えられた終了フラグ	0011	1111	1111	1111	1000
反転回路266	1100	0000	0000	0000	0111
レジスタ 274	1100 検出	0001 検出	1111	1100 検出	0111
PE 276	10	00	終了	10	00
X*座標出力	(000000¦10) =2	(000001¦00) =4		(000011¦10) =14	(000100¦00) =16
デコーダ 280	0010	1000		0010	1000
レジスタ 274	1110 検出	1001 検出		1110 検出	1111
PE 276	11	01		11	終了
X*座標出力	(000000¦11) =3	(000001¦01) =5		(000011¦11) =15	
デコーダ 280	0001	0100		0001	
レジスタ 274	1111	1101 検出		1111	
PE 276	終了	10		終了	
X*座標出力		(000001¦10) =6			
デコーダ 280		0010			
レジスタ 279		1111 終了			

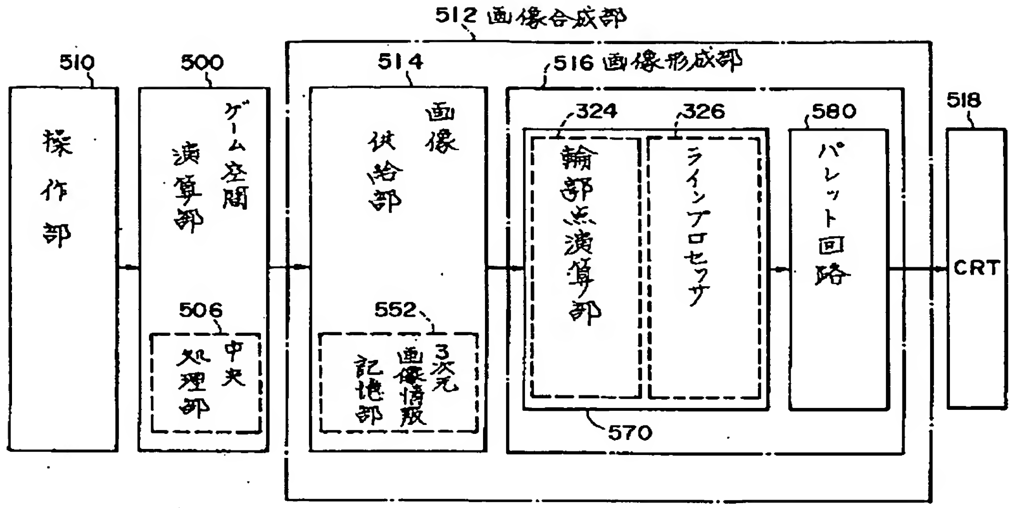
【図9】


1 画像合成部
12
操作部
13
ゲーム空間演算部
14
中央処理部
10
画像供給部
3次元画像情報記憶部
28 画像形成部
37
処理ドット指示部
36
終了フラグ記憶部
328
パレット回路
324
輪郭点演算部
326
ラインプロセッサ
322 ポリゴン発生回路
46
CRT

【図１０】


300
(1)
(3)
308
306
302
304

【図１１】


512 画像合成部
510
操作部
500
ゲーム空間演算部
506
中央処理部
514
画像供給部
552
3次元画像情報記憶部
516 画像形成部
324
輪郭点演算部
326
ラインプロセッサ
570
580
パレット回路
518
CRT